

ABSTRACTS
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* Author Presenting Paper

National Extension Education Workshop: Current and Future Impact of Issues Facing Animal Agriculture

1 Introduction. Richard Reynnells*¹, ¹USDA/CSREES/PAS.

There is insufficient understanding by society of our food supply network. Our agricultural system is simultaneously robust and fragile, so must be protected, but is taken for granted. Our agricultural future requires mutual respect and a search for truth, versus special interests and myopic agendas.

Technological advances at the molecular level demand we deal with bioethical issues. We require an honest evaluation of the consequences of progress. Our keynote speaker will address GMO's in the Food Chain. Society's demand for inexpensive food, coupled with competition and grocery store's efforts to fulfil those requirements eliminated many good farmers. Consumers are appalled at the consolidation of farms, yet show little concern about the consolidation of grocery and other stores. These issues will be discussed by two speakers and an industry panel. ADDS, Inc. personnel will discuss and demonstrate their unique educational program.

Activist groups protest vigorously, and some may be considered a secular religion. Can animal rights dogma be promoted as originally intended, or must it be sold on welfare or a reduced version of "rights"? Can industry withstand the crucible of common decency in dealings with animals? Do they deal progressively with societal issues? Prescriptive Production Issues will be discussed by a panel, then there will be comments on Farm Level HACCP. Animal agriculture is presented as the major contributor of water pollutants. Is the USEPA moving toward acceptable agricultural pollution through credits that allow pollution? The final session is a panel of environmental experts. Full papers will be available in independently published proceedings.

Key Words: GMO's, Prescriptive Production, Agricultural Consolidation

2 A Rational Discussion of GMOs in the Animal Food Chain. S.K. Harlander*, *BIOrational Consultants, Inc.*

In the relatively short time since their commercial introduction in 1996, genetically modified (GM) crops have been rapidly adopted in the U.S. Over 25% of the corn, 54% of the soybeans, 61% of the cotton and 70% of the canola grown in the U.S. and Canada in 2000 were GM varieties. These crops are treated as commodities and have found their way into the vast majority of ingredients used for human food products and animal feed. Because FDA considers these crops "substantially equivalent"

to their traditional counterparts, no special labeling is required for ingredients derived from GM crops in the U.S. Crops are typically not identity preserved or segregated from their non-GM counterparts and co-mingling is common in the supply chain. Certain consumers who wish to avoid GM foods have raised concerns about the use of GM crops in animal feed. They question the safety and fate of DNA and protein derived from GM crops once they are consumed by animals. Some have suggested that animals that have consumed GM crops should be labeled as such. International scientific organizations agree that GM crops are as safe or safer than conventional crops. The DNA and protein present in GM crops is digested in the same manner as endogenous DNA and protein present in the food supply. Numerous studies have also demonstrated that protein and DNA from GM crops is not detectable in various organs, meat, milk or eggs. Animal feeding studies in a variety of animal model systems have confirmed that GM crops are nutritionally equivalent to their conventional counterparts. Further, animal performance is equivalent for conventional and GM varieties. The techniques of genetic engineering can be applied to animals in a variety of ways to improve animal performance, alter composition, or to engineer animals to produce pharmaceuticals in their milk or blood. This presentation will provide a rational discussion of the broad applications of genetic engineering to the animal food chain and the logistical, regulatory and consumer acceptance issues created by this emerging capability.

Key Words: Genetically modified crops, Fate of DNA and protein, Labeling

3 The Economics of the Animal Protein Chain. A Barkema*¹, M Drabentott¹, and N Novack¹, ¹Federal Reserve Bank of Kansas City.

One of the most striking developments in the animal protein industry in recent years is its rapid consolidation, highlighted by three recent events. First, recent census data indicate just a tenth of the nation's farms account for fully two-thirds of U.S. agriculture's output of food and fiber. Second, the share of the nation's steers and heifers slaughtered by the four largest meat processors edged up to more than 81 percent in 1999, up from slightly more than a third in 1980. Third, Wal-Mart recently took the lead as the nation's largest food retailer, boosting the market share held by the four largest food retailers to about a third.

The industry's increased consolidation presents an important trade-off to both consumers and producers. On one hand, the consolidation heightens concern that big food companies could gain market power, pushing up food prices for consumers while pushing down commodity prices for producers. On the other hand, the consolidation could be beneficial, enabling more efficient product development and delivery systems while wringing out industry costs. Consumers could gain a wider selection of higher quality food products at lower prices. Producers could boost margins and manage risks by entering supply chain relationships with food companies. In either event, rural areas could see a new patchwork of growth and decline emerge as traditional farm-dependent communities wither and a comparatively small number of supply-chain hubs emerge.

These dramatic shifts in the economics of the animal protein chain pose big questions for policymakers. How much concentration is too much, and how do regulators know? What policy changes will help producers participate most profitably in the industry's new business structures? And how do rural communities position themselves to capture the benefits of the new livestock industry while minimizing any negative impacts? All of these questions point to the need to rethink the traditional approach to regulatory, farm, and rural policies that were built around commodities, a model that looks out of step with where the industry is headed.

Key Words: consolidation, concentration, food industry

4 Pork value chain economic concerns. Steve Meyer*, National Pork Producers Council, Des Moines, IA USA.

There is no "food" value chain. There is not even "a" pork value chain. In fact, there are hundreds of parallel value chains delivering foods of various varieties to consumers. They compete for consumer food dollars; a pool which has gotten smaller by opportunity, not necessity, in the U.S. New technology and the ability to apply it rapidly has allowed some producers, processors and retailers to gain cost advantages over competitors thereby enabling them to sell for less and create extreme economic pressure for rival firms. This pressure has, not surprisingly, forced many from the industry. The resulting consolidation has caused producer sector turmoil and political decisions aimed at economic problems. The issues for the future will be twofold. First, will the pork industry look to the consumer or producer end of the chain to decide who is "rightfully" served? Second, will value chain systems that equitably distribute the total consumer value be derived and, if so, will they provide enough income and profit to producers of live animals?

Key Words: value chain, consumer, equitably

5 Current and future challenges in the dairy food marketing chain. R. D. Yonkers*, International Dairy Foods Association.

All segments of the dairy marketing chain have undergone significant structural change in the past decade, a trend likely to continue. Increasing concentration exists among milk marketing cooperatives, dairy product processors and retailers and other outlets for dairy products. The dairy industry is characterized by low profit margins at all points in the marketing chain. In addition, the substantial level of government regulation of the dairy industry inhibits innovation at all levels, especially minimum price regulations and strict standards of identity for consumer products. The future growth of the U.S. dairy industry depends on successfully addressing the following challenges:

- 1) Transition current dairy industry regulations, which are nearly the same as those first developed in the 1930's and 1940's, to reflect current market realities.
- 2) Increase the dairy industry's cost competitiveness with other global dairy players as well as other domestic competitors for their share of the consumer stomach.
- 3) Successfully adopt existing and emerging technologies and develop product innovations designed to meet the changing consumer marketplace.

Key Words: Dairy markets, Dairy regulation, Cost competitiveness

6 The ADDS Program: facilitating cooperation and national leadership for agricultural knowledge delivery. J.M. Mattison*¹, M.B. Opperman¹, B.R. Eastwood², R.M. Kattnig³, and M.J. Joyce⁴. ¹ADDS Center, ²USDA-CSREES, ³University of Arizona, ⁴Wisconsin Milk Marketing Board.

The ADDS Program is a cooperative effort between USDA/CSREES, the Land Grant University system, producer commodity organizations and the private sector to develop information resources for decision support. These resources, or InfoBases, can be used by extension personnel, educators, producers and support personnel to facilitate the development of a decision support mechanism to benefit all of agriculture. Each InfoBase product is organized by a national committee of specialists representing Cooperative Extension, commodity producer groups and private industry. This committee sets the organizational structure of the InfoBase, including determining a project leader, organizing an editorial committee and developing review teams. The committee also develops guidelines for the information that will appear in an InfoBase, including subject areas, content requirements and review schedule. Standard operating procedures for the continuous updating and review of content are also outlined by the committee. This committee structure provides a forum for national leadership and cooperation for the development of specific commodity-based decision support tools. Each InfoBase committee selects three representatives to the ADDS, Inc board of directors. This board represents all active InfoBase groups, encompassing beef, poultry, dairy, pig, sheep, goat, catfish, FARAD and food safety industries. This groups maintains the policy and structure of the ADDS Center, which is the service bureau charged to facilitate the development, production and marketing of InfoBase products.

Key Words: Infobase, Decision, Knowledge

7 Prescriptive production issues - a UK / European perspective. Malcolm Mitchell*¹, ¹Roslin Institute.

In Europe, public and political concern relating to animal welfare and commercial production has increased dramatically. In particular, public awareness of the issues has been raised by extensive media coverage and the high profile activities of both animal welfare (e.g. UK Farm Animal Welfare Council) and animal rights organizations. Inextricably linked to the animal welfare concerns is the perception that modern intensive production systems have influenced food hygiene and human health (e.g. spongiform encephalopathies and salmonella infections). The result is an ever-changing background of interrelated legislation, codes of practice and quality assurance schemes regulating animal production, handling, transport, slaughter and processing. There are many participants in the development, implementation and policing of the regulations and codes. A major driving force for improvement is general public concern although the animal welfare lobby has drawn attention to specific problems. Much of the pertinent legislation originates at European level in the form of European Community Regulations and Directives. These are binding upon member states and must be implemented, by governments, through "domestic law". The standards defined in this manner may often come in to conflict with World Trade Organization agreements. Superimposed on this legal framework is the influence of the food retailers who in the UK can exert tremendous economic influence on animal producers. These retail organizations can achieve commercial advantage by promoting higher welfare standards and production systems. There are many recent examples of changes in agricultural practice resulting from all of these prescriptive pressures, including the abolition of pig farrowing cages and tethers, the phasing out of battery cages and the prohibition of amputation procedures. The increased costs of higher welfare standards and better production systems are generally borne by the producers and few subsidies for this purpose are available. A major challenge to the scientific community is to provide the sound, objective basis for improvements in welfare regulations and methods of production, which consider the well being of the animals but allow for the economic supply of high quality animal products.

Key Words: animal production, welfare, legislation

8 Government perspective on animal production food safety. Alice Thaler*, *USDA/FSIS, Washington, DC/USA.*

The Food Safety and Inspection Service (FSIS) is committed to ensuring food safety for meat, poultry and egg products using a farm-to-table approach. Issues affecting producers include regulatory requirements at slaughter, humane handling, and residues. FSIS has no direct regulatory authority on the farm; however, regulatory requirements at slaughter establishments will impact the relationship between producers and processors. The FSIS has 35 cooperative agreements with state regulatory officials and universities to educate producers about these impacts. These educational efforts in animal production are part of a larger change whereby FSIS will redefine the role of its veterinarians who will become public health professionals overseeing the effectiveness of farm-to-table food safety systems.

Humane issues potentially impact producers. FSIS considers humane methods of handling animals and humane slaughter operations a priority, and is committed to ensuring that there is compliance with the Humane Methods of Slaughter Act in federally inspected establishments that slaughter livestock. FSIS participates in the USDA Animal Well Being Task Group, which is comprised of agencies with regulatory authority over humane treatment of animals under prescribed circumstances, such as animals under exhibition. FSIS plans to develop objective criteria for determining whether observed handling and stunning practices for livestock are humane. Also, beginning with School Year 2000-2001 purchase, USDA will no longer accept ground beef that includes product from non-ambulatory cattle.

Residues continue to be an important issue in the minds of consumers. FSIS is developing an approach to regulatory enforcement that will be compatible with a HACCP environment. This may include condemnation of carcasses whenever a target tissue is found to exceed the regulatory tolerance for a pesticide or drug.

All in all, responsibility to prevent, reduce or eliminate hazards will be shared throughout the farm-to-table continuum. Industry quality assurance programs are expected to address more food safety issues in the future. This will be a major change for producers who do not currently have programs in place to address microbiological, chemical, and physical hazards.

Key Words: residues, HACCP, food safety

9 Overview of environmental protection concerns and potential solutions. H. F. Tyrrell*, *U. S. Department of Agriculture, CSREES, PAS.*

The impact of livestock production on the environment has evolved into a major issue confronting livestock producers in the United States. The U.S. Environmental Protection Agency has proposed new regulations for Animal Feeding Operations which will have major impact if enacted as proposed. The Supreme Court has upheld new Air Quality Standards which, for the first time, will include ammonia as a criteria pollutant under the National Ambient Air Quality Standards. The bottom line is that it will not be business as usual for livestock producers. The livestock industry is going to have to factor in the cost of dealing with nutrients entering and leaving the animal feeding operation by whatever route. The starting point for the development of nutrient management

systems has to be the application of mass balance principles to the total livestock production system. We have to be able to accurately identify source and fate of each nutrient as it moves through the production system. Route of loss will be different for each nutrient. Loss of nitrogen to the atmosphere, for example, can be the primary route from the production system to the environment whereas phosphorus loss via this route would be negligible. Only when one considers total mass flow of all nutrients through a livestock production system can realistic comparisons of alternative nutrient management strategies be made.

Key Words: Nutrient, Regulation, Environment

10 EPA's Vision—the Next Steps. Roberta Parry*, *U.S. Environmental Protection Agency, Washington, D.C..*

The U.S. Environmental Protection Agency (EPA) proposed new Confined Animal Feeding Operation (CAFO) regulations in January 2001. The regulations focus on preventing animal manure from reaching surface waters. Nutrients are the major pollutants of concern, since they are the number one cause of water quality impairments in lakes and the number three cause in rivers. Pathogens and sediment are also important pollutants from CAFO operations. In order to update the 25-year old CAFO regulations, EPA has proposed several changes to better protect water quality. These changes focus on three major areas: 1) who needs a permit (all CAFOs including dry poultry, immature swine and heifer operations, and integrators with substantial operational control over growers); 2) feedlot requirements (existing beef and dairy CAFOs and all new CAFOs—zero discharge to groundwater that is hydrologically connected to surface water),(veal, swine, and poultry—zero discharge with no overflow allowance); and 3) land application of manure (Permit Nutrient Plans including rate, timing, and method of application; 100' setback from water; maintaining records on manure transferred off-site). EPA has taken public comment on the proposal and will be revising the regulation for final action by December 2002. In addition to the CAFO proposal, the Total Maximum Daily Load regulation may require animal operations to adopt additional practices if the operations are in watersheds where agriculture impairs water quality. Livestock producers will need assistance from many different sources to understand their responsibilities under these regulations and implement changes on their operations.

Key Words: Confined Animal Feeding Operation, Water Quality, EPA Regulations

11 Industry View of Environmental Issues. C. H. Iltis*,¹ *National Milk Producers Federation.*

As a result of various federal, state, and local environmental initiatives, livestock producers are having to become increasingly aware of minimizing any potential environmental impacts on their farms. This presentation will review various initiatives to manage livestock waste from both regulatory and educational/technical assistance standpoints. In addition, we will discuss producer-led efforts to address their environmental concerns.

Key Words: Environmental, Livestock

Current Concepts of Animal Growth X: Metabolic and Cellular Regulation of Protein Deposition

12 Amino Acids: Regulators of Global and Specific mRNA Translation. S.R. Kimball*¹, ¹*Pennsylvania State University.*

A continuous supply of a complete complement of essential amino acids is a prerequisite for maintenance of optimal rates of protein synthesis in both liver and skeletal muscle. Deprivation of even a single essential amino acid causes a decrease in the synthesis of essentially all cellular proteins through an inhibition of the initiation phase of mRNA translation. However, the synthesis of all proteins is not repressed equally. Specific subsets of proteins, in particular those encoded by mRNAs containing a 5-terminal oligopyrimidine (TOP) motif, are affected to a much greater extent compared to most proteins. The specific decrease in TOP mRNA translation is a result of an inhibition of the ribosomal protein S6 kinase, S6K1, and a concomitant decline in S6 phosphory-

lation. Interestingly, many TOP mRNAs encode proteins involved in mRNA translation, such as elongation factors eEF1A and eEF2, as well as the ribosomal proteins. Thus, deprivation of essential amino acids not only directly and rapidly represses global mRNA translation, but also potentially results in a reduction in the capacity to synthesize protein.

13 Cellular Control of Protein Degradation. Didier Attaix*¹, Lydie Combaret¹, M-Noelle Pouch¹, and Daniel Taillandier¹, ¹*Human Nutrition Research Center of Clermont-Ferrand and INRA.*

A few years ago protein degradation was considered to be a global, non-selective and poorly regulated metabolic process that was mainly involved in housekeeping functions. This area of research has developed exponentially in the last decade, and it is now clear that many major biological functions are controlled by the breakdown of specific proteins. In

this respect, the ubiquitin-proteasome-dependent pathway is the most elaborate protein-degradation machinery known. The formation of a polyubiquitin degradation signal is required for proteasome-dependent proteolysis. Several families of enzymes, which may comprise hundreds of members to achieve high selectivity, control this process. The substrates tagged by polyubiquitin chains are then recognized by the 26S proteasome and degraded into peptides. However, the 26S proteasome also recognizes and degrades some non-ubiquitinated proteins. Indeed, several ubiquitin- and/or proteasome-dependent systems degrade specific classes of substrates and single proteins by alternative mechanisms and are presumably interconnected. They may also interfere or cooperate with other proteolytic pathways.

Key Words: Protein breakdown, Proteasome, Ubiquitin

14 Stress and Muscle Cachexia. P.O. Hasselgren*¹, ¹University of Cincinnati.

One of the metabolic hallmarks of sepsis and severe injury is a catabolic response in skeletal muscle. Muscle cachexia in these conditions is mainly caused by increased protein breakdown, although inhibited protein synthesis contributes to the negative nitrogen balance in skeletal muscle. Muscle protein breakdown during sepsis and following severe injury mainly reflects degradation of the myofibrillar proteins actin and myosin. There is evidence that a calcium-calpain-dependent release of the myofilaments from the sarcomere provides substrates for the ubiquitin-proteasome proteolytic pathway. Proteins degraded by this pathway are ubiquitinated and subsequently degraded by the 26S proteasome. Research in our laboratory has provided evidence that the gene expression of calpains as well as various components of the ubiquitin proteasome pathway is upregulated in skeletal muscle during sepsis and following severe injury. In addition, proteasome inhibitors block the increase in muscle protein breakdown seen in these conditions. Muscle cachexia in patients with stress has important clinical implications because it can prevent or delay ambulation, increasing the risk for thromboembolic complications and prolonging rehabilitation. In addition, when respiratory muscles are affected, there is an increased risk for pulmonary complications and a need for prolonged ventilatory support.

Key Words: Muscle, Proteolysis, Sepsis

15 Developmental Regulation of Protein Metabolism. T.A. Davis*¹, M.L. Fiorotto¹, and A. Suryawan¹, ¹USDA/ARS Children's Nutrition Research Center.

Growth and development are characterized by high rates of protein turnover that support rapid rates of protein accretion. The rate of protein deposition varies among tissues, with the growth rate of the skeletal musculature being amongst the highest. The efficiency with which dietary amino acids are utilized for protein deposition is high in neonates and decreases as the animal matures. This high efficiency is likely due to the enhanced stimulation of protein synthesis after feeding. The rise in protein synthesis in response to feeding and its developmental decline are more pronounced in skeletal muscle than for other tissues. In the neonatal pig, the postprandial rises in insulin and amino acids independently stimulate protein synthesis in skeletal muscle, whereas amino acids are the principal anabolic stimulus for liver. These developmental changes in protein synthesis are regulated by alterations in the expression and activity of components of the signaling pathway that controls the initiation of translation.

Key Words: Protein Synthesis, Insulin, Amino Acids

16 Muscle Wasting and Protein Metabolism. C. Castaneda-Sceppa¹, ¹Jean Mayer USDA Human Nutrition Research Center on Aging.

Accelerated muscle proteolysis is the primary cause of muscle wasting in many catabolic diseases such as diabetes mellitus, renal and liver failure, HIV infection and AIDS, and cancer. In individuals with catabolic diseases, as it is the case of fasting states (anorexia and starvation), protein breakdown increases while protein synthesis declines resulting in negative muscle protein balance. The pathway responsible for accelerated proteolysis in catabolic conditions is the ubiquitin-proteasome dependent system. Muscle proteolysis increases under conditions of acidosis,

up-regulation of branched-chain ketoacid dehydrogenase, the presence of catabolic hormones (glucocorticoids, thyrotoxic states), insulin resistance, and multiple cytokines (interleukin-1 and 6 and tumor necrosis factor). In contrast, factors that suppress muscle proteolysis and wasting leading to a state of adaptation include dietary protein deficiency with adequate energy intake, use of anabolic agents, and resistance exercise training. The understanding of the biochemical adaptation that reduce protein degradation and improve nitrogen balance are important for the development of effective therapies to combat muscle wasting and improve protein homeostasis with catabolic illnesses.

Key Words: Skeletal muscle loss, Protein turnover, Catabolism

17 Hormonal Regulation of Regional and Tissue Protein Turnover. S. Nair*¹, ¹Endocrinology Unit, Mayo Clinic.

Hormones are major regulators of protein turnover in humans. Whole body protein balance and tissue concentrations of specific proteins are determined by the balance between synthesis and degradation of proteins. Most of the hormonal actions are tissue and protein specific and the same hormone may inhibit synthesis of one protein but directly or indirectly stimulate synthesis of another protein. Hormonal effects are targeted at different levels of regulation of protein synthesis and degradation. Examples of hormonal imbalance resulting in profound changes in protein turnover is evident in type I diabetes. Insulin deficiency results in elevated glucagon and growth hormone levels in human. Insulin deficiency has been shown to result in profound muscle wasting by a net increase in muscle protein breakdown. High glucagon causes increased metabolic rate and accelerated leucine oxidation thus contributing to the catabolic state in diabetes. Other catabolic hormones such as cortisol also may contribute to catabolism. Insulin also is a key hormone involved in regulating the trafficking of amino acids across organs especially making amino acids available for synthesizing essential proteins in between meals. Recent interest has focused on insulin specific effects on certain proteins with specific functions such as mitochondrial proteins. Hormones also act in conjunction with substrates which modulates hormonal effect on protein turnover.

18 Exercise and Protein Metabolism. R.R. Wolfe¹, ¹University of Texas Medical Branch and Shriners Burns Hospital.

Resistance exercise training produces an anabolic effect on muscle, yet during exercise muscle protein synthesis is not stimulated, and muscle protein breakdown may be accelerated. The anabolic response begins after the exercise is completed. Muscle protein synthesis is elevated by about one hour after exercise, and remains elevated for as long as 48 hours. A simultaneous increase in muscle protein breakdown blunts the effect of the stimulation of synthesis on the net protein balance. Net muscle protein balance is improved after exercise, but remains negative unless nutrients are ingested. Thus, the "anabolic" response to resistance exercise occurs in the fed state, where ingested amino acids are incorporated into muscle protein to a greater extent than when ingested at rest.

19 Nutritional Regulation of Protein Metabolism. P.J. Garlick*¹, ¹State University of New York at Stony Brook.

Protein homeostasis depends on the balance between protein synthesis and protein degradation. In muscle of growing animals, feeding is accompanied by an increase in protein synthesis, resulting in net protein deposition. This has been shown to depend on amino acid supply and insulin secretion. In contrast, in the liver, protein deposition after feeding results mainly from an inhibition of protein degradation. At the whole body level, increasing nutrient intake in human preterm neonates has been shown to be associated with increased protein deposition, resulting from enhanced protein synthesis. In healthy adults there is no growth, but there is a need to retain protein after meals to counter the protein loss that occurs postabsorptively. The adult rat shows little stimulation of muscle protein synthesis by food intake or insulin infusion, whereas in human muscle the responses to nutrients or insulin remain controversial. Pathological conditions such as trauma and infection are characterized by muscle protein loss and a decrease in muscle protein synthesis, and much effort has been spent on strategies for reversing muscle wasting by nutritional and pharmacological means. However, nutritional support, even when supplemented with branched chain amino acids or glutamine, have not yet been shown to be effective.

ADSA Dairy Foods Graduate Student Paper Competition

20 Temperature effect on structure-opacity relationships of nonfat Mozzarella cheese. A.J. Pastorino^{*1}, R.I. Dave², C.J. Oberg³, and D.J. McMahon¹, ¹Utah State University, ²South Dakota State University, ³Weber State University.

Our objective was to determine the effect of heating on the structure of nonfat Mozzarella cheese, and then to relate changes in structure to changes in cheese opacity. Cheese was made according to a direct-acid, stirred-curd procedure. Cheese samples, at 4°C, were taken on d 1 and placed into glass bottles, which were sealed and heated. Once the cheese reached 10°C or 50°C, the bottles were placed on a scanner and color values measured. Samples of cheese at 10°C and 50°C were also taken on d 1 for structural analysis. Scanning and transmission electron micrographs of cheese were scanned and digitally analyzed. Applying heat increased cheese opacity, as measured by L-values (91.5 versus 78.0; $P < 0.001$), and induced changes in cheese structure. Larger protein aggregates (7.0 nm² versus 1.9 nm²; $P = 0.074$) and increased protein concentration in the protein matrix were observed in cheese at 50°C (i.e., increased aggregate density, 157 versus 91; $P = 0.008$). Applied heat would favor hydrophobic interactions, and possibly, re-association of β -casein and calcium with the protein matrix, promoting protein-to-protein interactions. Thus, the protein matrix contracted, occupying less cheese matrix area (69 versus 99%; $P = 0.022$) and microphase separation occurred, causing serum pockets to grow in size (from a maximum diameter of 1.0 μ m to 7.0 μ m), and microstructural heterogeneity increased. It is proposed that the increased size of aggregates and heterogeneity of the cheese at 50°C promote light reflection, thus increasing cheese opacity. We concluded that applying heat alters protein interactions in the cheese matrix, which is manifest as changes in cheese structure. Such changes in structure help provide an understanding of changes in cheese opacity.

Key Words: Cheese, Structure-Opacity, Temperature

21 Rheological properties of rennet-induced gels made from coagulants of vegetable origin and chymosin. C. L. C. Esteves^{*1,2}, J. A. Lucey¹, and E. M. V. Pires², ¹University of Wisconsin-Madison, Madison, ²University of Coimbra, Coimbra, Portugal.

The type of coagulant used in cheese-making plays an important role in the characteristics of the final product. In Portugal, the flowers of *Cynara* sp have been used for a long time in the production of vegetarian cheeses that are considered of high quality, because of their distinctive flavor and texture. However, little is known about the textural properties of rennet-induced gels made with vegetable coagulants. The rheological properties of rennet gels made from the vegetable coagulants *Cynara cardunculus* L. and *Cynara humilis* L. were compared with those of recombinant chymosin, using dynamic low amplitude oscillation. The large deformation properties of gels were studied by subjecting set gels to a constant shear rate (0.01 s⁻¹), up to yielding of the gel. Gelation experiments were performed at 32°C using NFDM reconstituted for 2 and 16 h, at 32°C. The general pattern of gelation curves was similar for the three coagulants. After 6 h of gelation, the storage modulus of chymosin and vegetable coagulants were 79±0.4 and 66±1.9 Pa, respectively for milk dissolved for 2 h and 74±0.2 and 57±2.4 Pa, respectively for milk dissolved for 16 h. The lower storage modulus in gels made from milk dissolved for 16 h was probably due to casein hydrolysis by plasmin. The effect of the time scale of the applied deformation on the rheological properties was determined by a frequency sweep (0.002 - 1 Hz). At low frequency (0.002 Hz), regardless of time allowed to dissolve the milk, loss tangent values for chymosin (0.54±0.01) were higher than those for *Cynara cardunculus* L. (0.49±0.01) and *Cynara humilis* L. (0.50±0.01). Higher loss tangent values indicate susceptibility to syneresis. The shear stress at yielding was higher for chymosin (53±2.2 Pa) than vegetable rennets (46±2.3 Pa), for milk dissolved for both periods. The shear strain at yielding was similar for all coagulants (0.98±0.11) except for chymosin (1.17±0.05) when milk was dissolved for 16 h. The rennet-induced gels made with *Cynara cardunculus* L. and *Cynara humilis* L. were alike, probably due to the similarity in their proteolytic enzymes.

Key Words: Vegetable coagulants, Rennet-induced gels, Rheology

22 Evaluation of Quality Properties of Butter and Ice Cream with a High Content of Linoleic and Oleic Acid. S Gonzalez*, S.S. Duncan, S.S. Sumner, S.F. O'Keefe, and J. Herbein, Virginia Tech, Blacksburg, VA/USA.

Milk fat composition determines specific rheological, sensory and physicochemical properties of dairy products such as texture, melting point, flavor, color, oxidation rates, and viscosity. Previous studies have shown that milkfat containing higher levels of long chain polyunsaturated fatty acids have lower melting point and decreased solid fat content which leads to softer textured products. An increased risk of higher oxidation rates can be a disadvantage of high levels of polyunsaturated fatty acids. Three different milkfat compositions were obtained through dietary manipulation of cows: high oleic content, high linoleic content and standard milkfat. Ice cream and butter were processed from the treated and control milk. The samples were then analyzed to measure differences in texture (firmness), oxidation rate and sensory perception. Textures of butter and ice cream were performed by doing compression measurements. No significant difference was found between control and treated ice cream samples. However untreated butters were firmer (10.54 J) than butters containing higher amounts of unsaturated fatty acids (6.09-6.95 J) in a temperature range of 4.3-5.5 C. Peroxide values in ice cream were measured before freezing and after sensory testing to monitor oxidation behavior of the three treatments. Initial peroxide values were similar between the treatments, however after 3 months of storage the values increased at a higher rate for the linoleic treatment. Sensory analyses included a scooping test on the three treated ice creams at -18C to detect differences in texture. An overall difference test was conducted to determine if consumers could taste a difference between the three ice cream treatments. The overall difference test showed significant difference between the control and the oleic treatment as well as the control and linoleic treatment at a p= 0.05. No significant difference was found in the scooping test.

Key Words: Ice cream , Texture, Linoleic and Oleic Acid

23 Effect of high-pressure on two strains of *Lactococcus lactis* subsp. *cremoris* in a phosphate buffered saline (PBS) cell suspension. A. S. Malone*, T.H. Shellhammer, and P. D. Courtney, Food Science and Technology, Ohio State University.

Cellular lysis or membrane permeability of cheese starter cultures is thought to play an important role in cheese ripening due to release of intracellular enzymes. Thus, researching a method, such as high-pressure processing, to induce or prohibit cell lysis or membrane permeability may provide a path to accelerate or arrest cheese maturation. Two strains of *Lactococcus lactis* subsp. *cremoris*, MG1363 and SK11, were grown to early stationary phase at 30°C in GM17 and LM17 broth, respectively. Cells were washed and resuspended in sterile phosphate buffered saline (PBS) at pH 7.0 to concentrations of approximately 6 X 10⁸ to 1 X 10⁹ cfu/ml. Cell suspensions were examined for their response to five minute, high-pressure treatments (100 to 800 MPa) at 25±4°C. Cell viability was assessed as cfu/ml immediately after pressure treatment. Both strains were completely inactivated at pressures of 400 to 800 MPa. There was no significant effect on cell viability at pressures of 100 and 200 MPa. At 300 MPa, the MG1363 population decreased by 7.3 log cycles, whereas the SK11 population decreased by 2.5 log cycles. Cell lysis was monitored by recording suspension absorbance at 600 nm (A₆₀₀) after pressure treatment for time intervals up to 24 hours. Pressure treated MG1363 cell suspensions decreased in A₆₀₀ over time when compared with non-pressure treated controls. Twenty-four hours after pressure treatment, the A₆₀₀ decreased by 0.15 to 0.30. The A₆₀₀ of pressure-treated SK11 suspensions did not differ significantly from non-pressure treated controls. These data indicate that high pressure can induce subsequent cell lysis and that lysis is strain dependent. Further studies are aimed at the extent of membrane permeability and autolysin activity in each strain after pressure treatment.

Key Words: *Lactococcus lactis*, high-pressure, lysis

24 Alpha-galactosidase as a novel molecular tool for the genetic modification of *Lactococcus lactis*. I. Boucher*¹, M. Parrot¹, C. Vadeboncoeur¹, and S. Moineau¹, ¹*Universite Laval, Quebec, Quebec, Canada.*

Atypical sugar fermentation phenotypes represent an attractive alternative to antibiotic resistance as a selection marker on plasmid vectors used for the genetic modification of lactic acid bacteria (LAB). For instance, melibiose is an alpha-galactoside rarely fermented by LAB. This disaccharide is hydrolyzed into galactose and glucose by alpha-galactosidase. The resulting monosaccharides are subsequently degraded through metabolic pathways that are commonly found in LAB. Using a degenerated oligonucleotide probe, the alpha-galactosidase gene (*aga*) and a gene coding for a transcriptional regulator from the LacI/GalR family (*galR*) of *Lactococcus raffinolactis* ATCC43920 were located on a 4 kbp DNA restriction fragment. When transferred into various *Lactococcus lactis* strains using the plasmid vector pNZ123, *aga* conferred the ability to ferment melibiose. A *Pediococcus acidilactici* strain also became melibiose-positive when transformed with the *L. raffinolactis* *aga* gene. Sequences coding for homologues of *L. raffinolactis* *aga* and *galR* products were also obtained from a raffinose-fermenting *L. lactis* subsp. *lactis* strain. The genes of both organisms displayed a similar organization on the chromosome and their nucleotide sequences were over 90% identical. *L. raffinolactis* *aga* was finally associated to the minimal region essential for the maintenance of a *L. lactis* natural plasmid to create a functional cloning device. Detection of melibiose-positive *L. lactis* transformants on a solid medium was made possible by first culturing transformed cells into an enrichment medium containing melibiose as the unique energy source. Constituted entirely of lactococcal DNA and exempt of antibiotic resistance determinants, this plasmid construction should be appropriate for food-grade applications. Lactococcal alpha-galactosidases represent a valuable new molecular tool suitable for the genetic modification of lactococci and other LAB.

Key Words: *Lactococcus raffinolactis*, alpha-galactosidase, selection marker

25 Influence of proteolytic enzymes from thermophilic lactic acid bacteria on the functional properties of Mozzarella cheese. B. S. Oommen*¹, D. J. McMahon¹, J. R. Broadbent¹, and C. J. Oberg², ¹*Utah State University*, ²*Weber State University*.

Part-skim Mozzarella cheeses were manufactured from 2%-fat milk using *Streptococcus thermophilus* as the starter and three different strains of *Lactobacillus delbrueckii* ssp. *bulgaricus* as adjunct starter culture to make three treatments and one without the addition of adjunct starter culture as the control. Three strains of the bacteria differed in their proteolytic specificity on α_{s1} -CN (f1-23) and their extent of proteolysis in milk. Based on their specificity, they were grouped as R2I, R6III, and R13V (this also represents the decreasing order of their extent of proteolysis) and the cheeses with those cultures were designated CR2I, CR6III, and CR13V respectively. Four replicates of these cheeses were aged and tested for functional attributes at 7, 14, and 21 d. Moisture, fat, and protein content in cheeses ranged from 45.2 to 48.4%, 19.9 to 20.5%, and 26.80 to 28.55% respectively. Salt content were not different ($P > 0.05$) among treatments. Cheese meltability increased ($P < 0.05$) from 58.05% in control to 81.86% in CR13V (CR2I, 73.20%; CR6III, 74.19%). TPA-hardness was 168.20 N for control and similar ($P > 0.05$) for CR2I (88.77), CR6III (101.45), and CR2I, CR13V (80.34 N). Melt strength, a measure of strand forming ability was highest ($P < 0.05$) for control (3.17 N) and lowest ($P < 0.05$) for CR13V (1.42 N). The ability of cheese strands to remain as a cohesive mass while being pulled called stretch quality was highest ($P < 0.05$) in control (0.6438 N) and lowest ($P < 0.05$) in CR13V (0.2113 N). Stretch quality and melt strength were similar ($P > 0.05$) for CR2I and CR6III. Meltability and TPA-cohesiveness increased ($P < 0.05$) with age while melt strength and stretch quality decreased ($P < 0.05$) with age. Water soluble peptides in cheese as measured by the total area under the peaks on HPLC correlated highly with meltability and stretch characteristics. Proteolytic specificity of lactic acid bacteria may be used as an indicator of the functional properties of the resultant cheese.

Key Words: Mozzarella, proteolysis, functionality

26 Fluorescence microscopy and recrystallization rate of model ice cream solutions as influenced by stabilizer type. A. Regand* and H.D. Goff, *University of Guelph, Guelph, Ontario, Canada.*

Stabilizers are known to retard ice recrystallization in frozen systems during storage at fluctuating temperatures, however the mechanism is not clear. Stabilizers were labelled with rhodamine isothiocyanate (RITC) and incorporated into solutions of sucrose (24%) and sucrose (16%) with skim milk powder (SMP) (14.7%). Solutions contained either no stabilizer or 0.3% of carrageenan, carboxymethyl cellulose (CMC), xanthan gum, sodium alginate, locust bean gum (LBG) or gelatine. The solutions were quenched frozen to -50°C, precycled to get similar ice crystal size at t=0 ($p \leq 0.05$), and cycled between -3.5°C and -6°C, 5 times. Different precycling treatments were required for samples with or without SMP due to lower initial values of ice crystal size in the presence of SMP. Digital brightfield and fluorescent images were acquired at t=0 and -3.5°C on each cycle. Recrystallization rate was calculated as the slope of the linear regression of the ice crystal median diameters obtained by the brightfield data. Location of the stabilizer was observed using fluorescence microscopy. Of the sucrose solutions, only the sample containing LBG showed a gel-like structure after cycling. Nevertheless, its recrystallization rate was not different from the control ($p \leq 0.05$). Lowest rates of recrystallization were detected with xanthan or alginate in sucrose solutions ($p \leq 0.05$). Cryo-gel formation and/or phase separation of proteins were identified by fluorescence microscopy after cycling in all solutions containing SMP. In the presence of proteins, all stabilizers retarded recrystallization compared to the control ($p \leq 0.05$). The most effective stabilizers in this case were alginate, CMC and carrageenan ($p \leq 0.05$), but they did not show any distinguishing structural features. These results suggest that molecular interactions between polysaccharides and proteins play an important role in retarding ice recrystallization. In the absence of proteins, cryo-gel formation is not essential to slow recrystallization.

Key Words: Ice Cream, Stabilizers, Fluorescence Microscopy

27 Monoclonal antibodies raised against native structural proteins of *Streptococcus thermophilus* bacteriophage DT1. C. Bart*¹, A. Darveau¹, C. Vadeboncoeur¹, and S. Moineau¹, ¹*Universite Laval, Quebec, Quebec, Canada.*

Streptococcus thermophilus is a lactic acid bacterium widely used for the production of yogurt and speciality cheeses. The manufacture of these dairy goods has risen sharply over the past years. A known fact about increased productivity within existing facilities is that milk fermentation processes may be delayed due to lytic bacteriophages. *S. thermophilus* phages are currently classified into two groups based on the number of major structural proteins (MSP) and their mode of DNA packaging. Phages with two MSP and cohesive genome extremities (costype) appear to occur more frequently. To better understand phage-host interactions, our laboratory recently sequenced the first genome of a costype lytic phage of *S. thermophilus*. The sequence analysis of DT1's genome revealed several open reading frames (ORF) coding for putative structural proteins. To confirm the presence of these proteins on the phage structure, monoclonal antibodies were produced using bacteriophage DT1 as the antigen. Furthermore, two different approaches were utilized, the classical method using mice spleen hybridoma cells and the phage-display technology. One antibody raised against the major capsid protein of DT1 was obtained by the first strategy and its specificity was confirmed by immunoelectron microscopy. An ELISA assay showed that this antibody has affinity for two out of the three 2MSP phages tested (DT1, MD4) and none for the two 3MSP phages tested. On the other hand, the phage-display technology allowed us to create a library of antibody fragments (ScFv) expressed as fusion proteins on the filamentous *E. coli* phage M13. Following two rounds of panning using complete DT1 phages as the antigen, four ScFv were chosen for further characterization. The phage-display library can be a useful tool in understanding the proteomic of phage DT1 and other phages of *S. thermophilus* since members of the same phage group (2MSP) share a high level of similarity in structural proteins.

Key Words: Monoclonal antibodies, Bacteriophages, *Streptococcus thermophilus*

28 Effect of linoleic and conjugated linoleic acids on *Lactobacillus* species in broth and milk. J. K. Jenkins* and P. D. Courtney, *The Ohio State University, Columbus, Ohio.*

Conjugated linoleic acid (CLA) is formed by the enzymatic or chemical isomerization of linoleic acid (LA). CLA is reported to reduce cancer cell growth, improve immune response and reduce body fat composition. Both CLA and LA are found in dietary triacylglycerols which are hydrolyzed by lipases in the human gastrointestinal tract. CLA content is highest among fatty dairy foods due to microbial activity in the rumen. Several bacteria have the ability to enzymatically isomerize linoleic acid to CLA. It has been hypothesized that bacteria may counteract the toxic effects of linoleic acid by converting it to a less toxic form, CLA. Studies directly comparing bacterial inhibition by both fatty acids are lacking. Five *Lactobacillus* strains from mammalian intestines or fermented dairy products were grown in MRS broth or UHT milk containing various concentrations of linoleic acid or CLA. All strains were inhibited to a greater extent by the fatty acids in broth than in milk. In MRS broth, fatty acid concentrations were 0, 250, 500, 750, or 1000 $\mu\text{g/ml}$ linoleic acid or CLA, whereas in UHT milk higher concentrations were used (0, 500, 1000, 3000 and 5000 $\mu\text{g/ml}$). Both fatty acids were more inhibitory at higher concentrations. CLA was consistently less inhibitory or less lethal than linoleic acid. The population of the most linoleic acid-sensitive strain was reduced by 3 log cycles after 10 hours in MRS broth containing 750 $\mu\text{g/ml}$ LA, whereas a slight increase (0.5 log) in population was observed with the same concentration of CLA. Free fatty acids can be present in foods and in the ileum, cecum and colon of humans, thus these results have implications regarding survival of *lactobacilli* in foods and human intestinal tract.

Key Words: *Lactobacillus*, conjugated linoleic acid

29 Development of two analytical methods to quantify the concentrations of insoluble and soluble Calcium in Cheddar cheese. A. V. Hassan* and J. A. Lucey, *University of Wisconsin-Madison.*

Two methods were developed, which could be routinely used to quantify the proportions of soluble and insoluble Ca in cheese. The concentration and type of residual Ca greatly influences cheese texture and functionality. The first method ("titration"), involved the use of a novel computer controlled, acid-base titration system to quantify buffering properties of milk and cheese. During acidification of milk, there was a well-defined buffering peak with a maximum at pH 5.1, due to the solubilization of colloidal calcium phosphate (CCP). When cheese was acidified there was a strong buffering peak at pH 4.8 which was due to residual CCP of milk that was not solubilized during cheese making. The area of this buffering peak in cheese was expressed as a percent of the original area of this peak in milk and was used to estimate the concentration of residual CCP (insoluble Ca) in cheese. Cheddar cheese homogenates were prepared for titration by mixing 8 g of cheese with 40 g of distilled water at 50°C in a homogenizer for 3 min. Cheese homogenates and milk samples were titrated from initial pH of cheese and milk to pH 3.0 with 0.5 M HCl and then back titrated to pH 9.0 with 0.5 M NaOH at 25°C on a Mettler DL50 Autotitrator. Total area under this buffering peak was analyzed using a program developed with MatLab software. Proportion of soluble Ca in cheese increased from 36% to 44% of total Ca during the first four wk of ripening. The second method was based on extracting the aqueous phase ("juice") of cheese under high pressure (Morris et al., 1988) and determining the concentration of soluble Ca in juice using atomic absorption spectroscopy. 800 g of freshly grated cheese was thoroughly mixed with 1000 g of sand and placed in a specially designed stainless steel mould, and subjected to pressures up to 8 MPa, over a period of 3 h. To remove fat, the juice was centrifuged at 1650 g for 10 min at 4°C. By this "juice" method the proportion of soluble Ca in cheese increased from 33 to 38% of total Ca during the first four wk of ripening. Both methods gave similar results for the proportions of soluble and insoluble Ca in cheese. These methods will be very useful tools in monitoring changes in the detailed mineral composition of cheese during ripening.

Key Words: Calcium, Buffering, Cheese texture

30 The effects of NaCl, CaCl₂, lactose and pH on the interfacial behavior of β -lactoglobulin. J P Davis* and E A Foegeding, *North Carolina State University, Raleigh NC/USA.*

Changes in the dynamic surface tension of aqueous β -lactoglobulin (10 μM) solutions, with varying concentrations (0-0.4 M) of either NaCl, CaCl₂ or lactose, were investigated using a pendant drop technique. Surface tension was measured over a time scale of 0 to 1200 s with a 2 s resolution. For all treatments, two distinct regions of protein adsorption were observed: 1) an initial rapid and nonlinear decrease in surface tension (0 to 250 s) followed by a 2) more gradual, linear decrease in surface tension (250 to 1200 s). The rate of decline for the second region was very similar for all treatments and no treatment had reached equilibrium by 1200 s. Therefore, the final values of surface tension for any treatment depended mainly on the processes occurring during the first 250 s. At pH 5.0, which is near the isoelectric point of 5.2 for β -lactoglobulin, the initial rate of adsorption was greatest for all treatments due to the reduction of an electrostatic energy barrier at the air/aqueous interface. At pH levels above (pH 7.0) and below (pH 3.0) the isoelectric point of β -lactoglobulin, the initial adsorption was significantly slower. The addition of either NaCl or CaCl₂ at levels up to 0.1 M increased the initial rate of adsorption due to a reduction of the electrostatic barrier to protein adsorption. The effect of lactose concentration was minimal.

The success of any protein-based food foam ultimately depends on the initial rapid adsorption of the protein and its subsequent behavior, i.e. unfolding and protein-protein interactions. Our results suggest that pH, NaCl and CaCl₂ mainly alter the rate and extent of surface tension decrease. Once β -lactoglobulin is adsorbed, the gradual unfolding and lowering of interfacial tension is the same regardless of pH or co-solute.

31 Isolation and Analysis of Glycomacropeptide from Goat Sweet Whey. Eryck Silva*, Takuo Nakano, and Lech Ozimek, *University of Alberta, Edmonton, Alberta, Canada.*

Glycomacropeptide (GMP) found in cheese whey (or sweet whey) is the hydrophilic C-terminal peptide released from k-casein by the action of chymosin during cheese making. GMP has been the subject of growing interest in recent years. Because of its various biological activities, and unique amino acid composition having no phenylalanine, GMP is thought to be a potential ingredient for dietetic foods and pharmaceuticals. Bovine GMP has been studied in many laboratories. There is, however, very limited information available on goat GMP. This study was, therefore, undertaken to purify GMP from goat sweet whey, and to determine its chemical composition. A sample of sweet whey was prepared from pasteurized goat milk by chymosin treatment. After dialysis, the whey sample was applied to an anion-exchange column of DEAE-Sephacel (Pharmacia Biotech Inc.) equilibrated with water adjusted to pH 3.0. Most GMP, accounting for 97 % of total recovered sialic acid (a carbohydrate moiety of GMP), was adsorbed on DEAE-Sephacel and eluted from the column by applying 1 M NaCl. The GMP fraction obtained after DEAE-Sephacel chromatography was further purified using hydrophobic interaction chromatography on phenyl-agarose (Sigma Chemical Co.) equilibrated with 0.01 M sodium phosphate, pH 6.8 containing 5 M NaCl. The final preparation of GMP, corresponding to 0.06 % (w/v) of sweet whey, was of considerably high purity with its amino acid composition showing a trace (0.4 mol % or < 1 residue/peptide) of phenylalanine. The overall amino acid composition in goat GMP is, in general, comparable to that in bovine GMP. The content of sialic acid was, however, approximately three times lower in goat (25 mg/mg dry weight) than in bovine (80 mg/mg dry weight) GMP. It was concluded that goat sweet whey is a potential source to prepare GMP to partially substitute amino acids used for the dietary treatment of phenylketonuria.

Key Words: Glycomacropeptide, Goat whey, Sialic acid

32 Effects of NutriDenseTM and waxy corn hybrids on site and extent of starch and protein disappearance and efficiency of microbial N production in sheep. V. Akay*, J. A. Jackson, and D. L. Harmon, *University of Kentucky, Lexington.*

Corn grains harvested from the corn hybrids, Exsegen 617 (conventional yellow dent corn), Exsegen 404ND (NutriDenseTM corn, high oil and protein), and Exsegen ESX4WX (waxy corn, high amylopectin) from ExSeed Genetics L.L.C. (Decatur, IL) were used in a study to investigate their effects on site and extent of starch and protein disappearance, and efficiency of microbial N production. Six wether lambs surgically fitted with ruminal, duodenal, and ileal cannulas were fed three diets in a 3 x 6 Latin rectangle design with 21 d periods. Diets were: 1) conventional yellow dent corn (CC), 2) NutriDenseTM corn (NC), and 3) waxy corn (WC). Diets contained approximately 44.0% cracked corn grain, 39.0% cottonseed hulls, 15.0% soybean meal, and 2.0% mineral and vitamin mix (DM basis). Chromic oxide (0.21% of DM) was used as a marker. Lambs were fed twice daily in the amount of 1.8 x NE_m requirement. Data were analyzed using GLM procedure of SAS. True starch disappearance in the rumen was higher for WC than CC (86.9, 91.4 and 98.5% for CC, NC and WC, respectively). Apparent starch disappearance in the small intestine was higher for NC and WC than CC (88.3, 93.8 and 95.9% of duodenal starch flow for CC, NC and WC, respectively). Apparent daily starch disappearance in the hindgut was higher for CC than WC (7.61, 1.79 and 0.24 g/d for CC, NC and WC, respectively). Apparent total tract starch disappearance was highest for WC and lowest for NC (99.8, 99.7 and 99.9% for CC, NC and WC, respectively). Daily flow of total N, bacterial N, NH₃-N, and non-NH₃ nonbacterial N at the duodenum were similar among diets. Bacterial N production efficiencies, (gram of bacterial N per kg of true or apparent OM disappearing in the rumen) were similar among diets. Apparent N disappearance from the small intestine was also similar among diets. However, apparent N disappearance from the hindgut was -0.81, -1.06 and -1.46 g/d for CC, NC and WC, respectively, and demonstrated a statistically significant effect between CC and WC diets. Total tract apparent N disappearance was similar among diets. Results suggested that starch in waxy corn grain is more digestible in the rumen than conventional yellow dent corn. This higher starch digestion, however, did not increase bacterial N production compared to conventional yellow dent corn.

Key Words: NutriDenseTM, Waxy, Disappearance

33 Synthetic conjugated linoleic acid may cause mammary involution in dairy cows. J.A. Bell* and J.J. Kennelly, *University of Alberta, Edmonton, Canada.*

In view of the potential of synthetic CLA as a means to increase the CLA content of bovine milk, this study was undertaken to evaluate the effect of synthetic CLA on milk component synthesis. Four Holstein cows received abomasal infusion of: (1) control, no fat infusion (CTL), (2) 150g/day of synthetic CLA, 31.7% c-9, t-11; 30.4% t-10, c-12 (CLA), (3) 150g/day of safflower oil (SAFF), and (4) 150g/day of tallow (TALL). Infusion was carried out for 20-22 hours/day for 11day periods in a 4x4 Latin square design. Data from the last two days of each period was used for statistical analysis. The milk fat concentration of c-9, t-11 CLA was 0.59, 0.58, 0.61, and 1.77% of fatty acid methyl esters for CTL, SAFF, TALL and CLA respectively. The concentration of t-10, c-12 CLA was 0.85% for CLA, but not detected with the other treatments. Milk yield dropped by 35 to 40% with CLA infusion. Percentage and yield of lactose and fat were also significantly lower with CLA. The surprisingly lower concentration of lactose with CLA infusion was counterbalanced by a higher concentration of sodium. Percentage of protein was significantly higher with CLA infusion although the yield of protein was lower compared to the other treatments. Somatic cell count was approximately five to seven times greater as a result of CLA infusion compared to the other treatments. This was unexpected since there were no visible signs of mastitis during milking. Subsequent analysis of the milk revealed no evidence of bacterial infection. During the early stages of drying-off similar changes are seen in the mammary secretion as were observed with infusion of CLA. Although purely speculative, it is possible that infusion of unnaturally large amounts of these synthetic CLA isomers was initiating the involution process in the mammary gland.

Item	CTL	TALL	SAFF	CLA
Milk yield, kg/day	24.2 ^a	23.0 ^a	26.6 ^a	15.0 ^b
Lactose, %	3.86 ^a	3.86 ^a	4.04 ^a	3.36 ^b
Fat, %	2.36 ^a	2.46 ^a	2.39 ^a	1.66 ^b
Protein, %	3.04 ^a	2.98 ^a	3.14 ^a	4.35 ^b
Somatic cell count, X1000/ml	187 ^a	193 ^a	133 ^a	991 ^b
Sodium, mg/kg	715 ^a	748 ^a	658 ^a	978 ^b
Chloride, %	0.192 ^a	0.192 ^a	0.188 ^a	0.252 ^b

Within a row, values with different superscripts are significantly different (P < 0.05).

Key Words: Conjugated linoleic acid, involution

34 The biohydrogenation of oleic acid to trans monoenes by ruminal microbes in vitro. E. E. Mosley*, T. C. Jenkins, and G. L. Powell, *Clemson University, Clemson, SC.*

According to most reports, oleic acid is directly hydrogenated to stearic acid by ruminal microbes without the formation of *trans* intermediates. However, feeding fat supplements high in oleic acid content to lactating cows has often increased the concentration of *trans* monoenes in ruminal contents and milk. The purpose of this study was to determine if *trans* monoenes are formed from oleic acid biohydrogenation or if oleic acid is directly hydrogenated to stearic acid as depicted in reviews. Oleic-1-¹³C acid and oleic acid were each added to four in vitro cultures of mixed ruminal microbes taken from a ruminally cannulated Holstein cow. Samples were taken at 0, 24, and 48 hours and methylated. Fatty acid methyl esters (FAME) were separated into fatty acid fractions differing in degree of saturation using a silver impregnated solid phase extraction column. The unsaturated FAME fractions were converted to dimethyl disulfide derivatives and analyzed by gas chromatography mass spectrometry. After 48 hours, the concentrations of oleic acid decreased 1.9 mg/5 ml of culture, stearic acid increased 1.3 mg/5 ml of culture, and *trans* monoenes increased 0.3 mg/5 ml of culture. Total *trans* monoenes at 48 hours averaged 0.4 mg/5 ml of culture and consisted of *trans*-9 (49%), *trans*-10 (16%), *trans*-11 (25%), and *trans*-12 (9%) octadecenoic acids. Enrichments were calculated from the mass abundance of ¹³C in major fatty acid fragments and expressed as a percentage of total carbon isotopomers. Enrichment of ¹³C at 0 hours was found in stearic acid (10.9%), oleic acid (85.2%), and *trans*-9 (85.4%) octadecenoic acid. At 24 hours, enrichment of ¹³C was found in stearic acid (37.5%), oleic acid (84.8%), *trans*-9 (85.0%), *trans*-10 (77.4%), *trans*-11 (39.9%), and *trans*-12 (72.7%) octadecenoic acids. At 48 hours, enrichment of ¹³C was found in stearic acid (35.8%), oleic acid (85.3%), *trans*-9 (84.2%), *trans*-10 (77.1%), *trans*-11 (47.4%), and *trans*-12 (73.3%) octadecenoic acids. It can be concluded that the biohydrogenation oleic acid by mixed ruminal microbes involves the formation of several positional isomers of *trans* monoenes rather than only stearic acid as previously described.

Key Words: Oleic acid, Biohydrogenation, *Trans* monoenes

35 Effects of long chain unsaturated fatty acids on palmitic acid metabolism by ruminant hepatocytes. D.G. Mashek*, S.J. Bertics, and R.R. Grummer, *University of Wisconsin, Madison.*

The objective was to determine the effects of long chain unsaturated fatty acids on the metabolism of palmitic acid to oxidation or cellular lipid products. Hepatocytes were isolated from four ruminating calves and exposed in suspension for 3 hours to one of the following treatments: 1 mM palmitic acid (1C16), 2 mM palmitic acid (2C16), or 1 mM of palmitic acid plus 1 mM of oleic (C18:1), linoleic (C18:2), linolenic (C18:3), eicosapentaenoic (C20:5), or docosahexaenoic (C22:6) acid. Oxidation of [1-¹⁴C]palmitic acid to CO₂ and acid-soluble products (ASP), or incorporation into cellular triglyceride (TG), phospholipid (PL), cholesterol (C), and cholesterol ester (CE) were measured. Overall, addition of C20:5 yielded the highest rates of palmitic acid oxidation followed by addition of C18:1 and C22:6. Addition of C18:2 or C18:3 resulted in the lowest rates of palmitic acid metabolism to most metabolic products, whereas addition of C18:1 and 2C16 yielded the highest rates of palmitic acid incorporation into TG and total cellular lipids. Addition of C20:5 and C22:6 yielded the highest rates of palmitic acid incorporation into C and, similar to C18:2 and C18:3, decreased TG formation from palmitic acid compared with the addition of C16 or

C18:1. These results show that long chain unsaturated fatty acids can have a direct affect on palmitic acid metabolism by bovine hepatocytes. Values in the table below represent incorporation of [^{14}C]palmitic acid into metabolic products (pmol/ μg DNA/3 h).

Prod.	1C16	2C16	C18:1	C18:2	C18:3	C20:5	C22:6	SEM
CO ₂	74.9 ^{bc}	66.4 ^{cd}	87.3 ^{ab}	56.8 ^d	73.8 ^{bc}	96.2 ^a	94.2 ^a	14.7
ASP	253.8 ^{bc}	203.7 ^{cd}	314.4 ^b	174.1 ^d	262.3 ^{bc}	417.0 ^a	289.2 ^b	50.0
Total Oxidation ¹	328.6 ^{cd}	270.0 ^{de}	401.7 ^b	230.9 ^e	336.3 ^c	513.2 ^a	388.4 ^{bc}	62.7
TG	192.7 ^b	299.4 ^a	289.5 ^a	146.2 ^c	178.6 ^{bc}	219.6 ^b	19 5.0 ^b	48.5
PL	102.8 ^{bc}	126.5 ^a	108.8 ^b	81.0 ^d	89.8 ^{cd}	108.3 ^b	102 .9 ^{bc}	15.1
C	29.3 ^{bc}	34.7 ^b	34.6 ^b	28.9 ^{bc}	24.9 ^c	42.1 ^a	47.5 ^a	8.1
CE	36.2 ^b	47.6 ^a	41.0 ^{ab}	39.2 ^{ab}	38.8 ^b	37.5 ^b	37.6 ^b	10.4
Total Cellular Lipid ²	362.2 ^{bc}	507.2 ^a	474.1 ^a	295.0 ^d	330.9 ^{cd}	379. 7 ^{bc}	392.2 ^b	70.5

^{abcde}Means within a row with unlike superscripts differ ($P < 0.05$). ¹Total Oxidation = CO₂ + ASP. ²Total Cellular Lipid = TG + PL + C + CE.

Key Words: fatty acids, hepatic metabolism, bovine

36 Programmed exercise altered carbohydrate and lipid metabolism of dairy cows. J. A. Davidson* and D. K. Beede, Michigan State University, East Lansing.

Objective was to determine the effects of a programmed exercise regimen (PER) and pregnancy of dairy cows on blood glucose (GLU), lactate (LACT), non-esterified fatty acid (NEFA), β -hydroxybutyrate (BHB) concentrations and glucose tolerance. Holstein non-lactating, multiparous pregnant or non-pregnant cows (n=52) were blocked by parity and expected calving date and assigned randomly to treatments: no exercise or exercise at a walk (3.25 km/h) every other day for 1.25 h, d 0 to 30; and, 1.5 h, d 31 to calving (d 70 of PER) in a mechanical walker with a circular lane (33.8 m circumf.). All cows completed treadmill exercise tests (ET) on d 0, 30 and 60 of PER. Treadmill ET consisted of walking 4 km/h for 3 min followed by 5 km/h with incremental increases in incline every 3 min until cows refused to walk. Jugular blood was sampled every 3 min during ET and 18 min recovery period (RP) after ET. Venous plasma concentrations of GLU and LACT were higher for non-exercised compared with exercised cows and increased as time increased during ET ($P < 0.05$). Plasma LACT concentrations were slightly higher for exercised pregnant cows compared with exercised non-pregnant cows ($P < 0.05$). Concentrations of NEFA during ET were higher for pregnant cows compared with non-pregnant cows and higher for non-exercised compared with exercised cows ($P < 0.07$). Concentrations of BHB declined faster for exercised cows compared with non-exercised cows as time during ET increased ($P < 0.05$). During RP, plasma concentrations of GLU, LACT, and NEFA decreased as time increased ($P < 0.01$). Exercised cows had lower plasma LACT than non-exercised cows during RP for d 60 ET compared with d 0 and d 30 ET ($P < 0.05$). Concentrations of BHB during RP were higher for exercised compared with non-exercised cows as time increased ($P = 0.05$). During the RP following d 60 ET, concentrations of NEFA were highest for pregnant cows as compared with non-pregnant cows ($P < 0.01$). The PER did not affect glucose tolerance. During glucose tolerance tests, pregnant cows had lower basal concentrations of GLU and insulin compared with non-pregnant cows. When given a GLU bolus (150 mg/kg BW), plasma insulin increased less for pregnant compared with non-pregnant cows ($P < 0.05$). The PER altered GLUC, LACT, BHB and NEFA metabolism during ET, but did not alter glucose tolerance.

Key Words: Exercise, Pregnancy, Dairy cows

37 Bovine lymphocytes express prolactin receptor (PRL-R) mRNA: a potential mechanism for PRL effects on immune function. T. L. Auchtung*, P. E. Kendall, and G. E. Dahl, University of Illinois, Urbana-Champaign.

Photoperiod is known to influence prolactin (PRL) secretion in cattle and has been implicated in enhancement of the immune system in rodents. Such enhancement is potentially through the actions of PRL, which is known to have cytokine-like activity. Lymphocytes of humans and rodents are known to express PRL-R mRNA, however no studies

have been performed to show the existence of PRL-R mRNA in lymphocytes of cattle. In addition, whether photoperiod has an effect on expression of PRL-R in cattle has not been studied. The objective of this study was to determine the existence of PRL-R mRNA in lymphocytes and to gain initial insight into the possibility that photoperiod influences the immune function in cattle. Blood was collected from Holstein calves via jugular venipuncture and lymphocytes were separated by centrifugation on Ficoll hypaque density gradients. Total RNA was isolated from lymphocytes using TRIzol reagent, and converted to cDNA. Real-time polymerase chain reaction (PCR) was performed using an ABI PRISM[®] 7700 Sequence Detector, with 18S as the endogenous control. Bovine lymphocytes expressed PRL-R mRNA suggesting that PRL may have direct action on these immune cells. Thus it is likely that PRL, as mediated by photoperiod, may have an impact on immune function in cattle via its receptors in lymphocytes. Further studies are underway to begin to elucidate the effects of photoperiod on PRL-R expression in lymphocytes.

Key Words: Cattle, Prolactin receptor, Lymphocytes

38 Trends in milk production and composition in dairy herds in Saskatchewan: August, 1997 to July, 2000. C.R. Richardson* and D.A. Christensen, University of Saskatchewan.

The objective was to study trends of milk production and milk composition in dairy herds in Saskatchewan, Canada over three years. The first two years of the study, the province was on a volume based pricing system and quota system. Both multiple component pricing (MCP) and a quota system based on kilograms of butterfat were implemented on the first day of the final year of the study. From August 1, 1997 to July 31, 2000 farm numbers decreased from 402 farms to 381 farms. However, total milk production for the province increased linearly each year. In the 1997-1998 dairy year milk fat percentage, milk protein percentage and other solids percentage were 3.63, 3.25 and 5.51 % respectively. In 1998-1999 the milk composition was 3.64% for milk fat, 3.26 % for milk protein and 5.52 % for other solids. During the final year of the study, milk fat, milk protein and other solids percent were 3.66, 3.23 and 5.51 % respectively. Results show that during the 1999-2000 dairy year, milk fat percentage was higher ($P < 0.05$) than in 1997- 1998 and 1998- 1999. Milk protein percentage was significantly lower ($P < 0.05$) in 1999-2000 than in the previous two years of the study. Seasonal variation for milk production and milk fat percentage was similar for all years. Milk protein and milk fat percentages were highest in the October, November and December (fall) and lowest in the June, July and August (summer). Milk protein percentage was similar for 1997-1998 and 1998-1999 dairy years with the exception of November 1998, which was significantly higher than in other years. In the 1999- 2000 dairy year, milk protein percent was lower than other years from November to March. Changes in milk production and composition may have reflected a change in policy of milk pricing and quota allocation. Because of the economic advantage to producers, it would be expected that milk production would go up. However, it was unexpected for milk fat percentage to go up and milk protein percentage to go down.

Key Words: milk composition, multiple component pricing, trends

39 The effects of dietary protein fractions and levels on performance and nitrogen utilization and excretion in early lactation dairy cows. S. Davidson*, B.A. Hopkins, D.E. Diaz, S.M. Bolt, C. Brownie, and L.W. Whitlow, North Carolina State University.

Treatment diets varying in crude protein (CP) and rumen undegradable protein (RUP) and calculated to supply a duodenal Lys:Met ratio of about 2.9:1 were corn silage based and fed as a TMR to sixty-five Holsteins from 21 to 120 days in milk to determine effects on performance and nitrogen utilization. Diets contained %CP and calculated %RUP (of CP) as follows: 1) 19.4%, 40% (CON), 2) 16.5%, 34% (LPLU), 3) 16.8%, 40% (LPMU), 4) 16.8%, 46% (LPHU), 5) 17.2%, 43% (LPHU+UREA), which is the result of adding 1% urea to LPHU. Diets contained approximately 24% ADF, 1.5 Mcal/kg NE_L, and 6.5% fat. Milk urea nitrogen (MUN) values were used to calculate predicted amounts of urinary nitrogen (UN) using the relationship: UN (g/d) = 12.54 X MUN (mg/dl). CON cows had greater CP and RUP intake, plasma urea nitrogen, rumen ammonia, MUN and predicted UN. Milk yield, fat yield, fat percent, protein yield and protein percent were not significantly different

($P > 0.05$). Cows on CON gained more weight than cows on other treatments ($P < 0.025$). Parity by treatment was not significant ($P > 0.05$). In this study, cows fed LPHU had lower MUN and predicted UN without limiting production.

Item	CON	LPLU	LPMU	LPHU	LPHU + UREA	Treatment P <	Parity P <
DMI (kg/d)	23.32	22.88	23.12	23.39	24.08	.823	.001
CP intake (kg/d)	4.53 ^a	3.78 ^b	3.89 ^b	3.92 ^b	4.13 ^b	.001	.001
RUP intake (kg/d)	1.81 ^a	1.29 ^b	1.55 ^c	1.80 ^a	1.78 ^a	.001	.001
ADF intake (kg/d)	5.46	5.57	5.99	5.36	5.72	.107	.001
NE _L intake (Mcal/d)	36.07	34.96	34.79	36.18	37.10	.576	.001
Milk yield (kg/d)	35.28	32.98	33.50	33.34	35.25	.748	.001
Milk CP%	3.11	3.01	3.02	3.04	3.06	.583	.341
Milk fat%	3.35	3.36	3.42	3.17	3.05	.137	.356
MUN (mg/dl)	21.92 ^a	15.99 ^b	17.57 ^c	14.32 ^d	17.03 ^{b,c}	.001	.44 4
Predicted UN (g/d)	274.5 ^a	200.2 ^b	220.0 ^c	179.2 ^d	213.3 ^{b,c}	.001	.448
PUN (mg/dl)	15.62 ^a	11.71 ^{b,c}	12.37 ^b	10.68 ^c	12.59 ^b	.001	.13 0
NEFA (Meq/l)	.168	.197	.210	.188	.206	.193	.001
Rumen NH ₃ (mg/dl)	12.10 ^a	8.39 ^{b,c}	9.27 ^b	7.38 ^c	9.21 ^b	.001	.155
A:P ratio	2.33	2.50	2.53	2.46	2.32	.193	.330

*LS Means Reported

Key Words: Rumen undegradable protein, Nitrogen excretion, Dairy cattle

40 The effect of increasing alfalfa haylage particle size on physically effective NDF values. P.J Kononoff^{*1}, A.J Heinrichs¹, H.A Lehman¹, and M.R Long¹, ¹*Pennsylvania State University*.

Physically effective NDF (peNDF) is defined as that dietary fiber source which effectively stimulates rumination and salivation. The peNDF value of feed has been determined by measuring the amount of NDF retained on a 1.18 mm screen. Changing cut length of forage results in changes in the proportion of large particles (>19.0 mm). The Penn State Particle Separator (PSPS) was modified to measure both small (<1.18 mm) and large particles. The objective of this experiment was to evaluate effective fiber requirements of cows in early lactation based on measurements of the PSPS. Eight cannulated, multiparous cows averaging 19 DIM and 642 kg BW were assigned to one of two 4X4 Latin Squares. During each of the 23 d periods animals were offered one of four diets, which were chemically identical but included alfalfa haylage of different particle size; short (SH), mostly short (MSH), mostly long (MLG), and long (LG). Total peNDF was similar across diets (27.2, 27.7, 27.9, 28.1) but the amount of particles >19.0 mm increased with increasing particle size (3.0, 12.4, 21.9, 31.3%). Increasing haylage particle size decreased DMI linearly (23.3, 22.0, 20.9, 20.8 kg for SH, MSH, MLG, LG respectively; $P < 0.05$). Milk production and percent fat did not differ across treatments ($P > 0.10$; 35.5 kg milk, 3.32% fat). Ruminal pH increased quadratically (6.04, 6.15, 6.13, 6.09; $P < 0.05$) but A:P ratio increased linearly (2.75, 2.86, 2.88, 2.92; $P < 0.0001$) with increasing particle size. Total time ruminating increased quadratically (467, 498, 486, 468 min/d; $P < 0.05$) but time eating increased linearly (262, 253, 298, 287 min/d; $P < 0.05$) with increasing particle size. Both eating and ruminating efficiency increased with increasing particle size (11.2, 11.5, 14.1, 14.1 min/kg DM; 20.5, 23.2, 23.4, 23.9 min/kg DM; $P < 0.05$). Based on rumen pH and total time ruminating, these results suggest higher effective fiber values should be assigned to rations with 12-22% of the particles >19.0 mm and that peNDF values should be adjusted based on the proportion of larger particles in the diet.

Key Words: NDF, pH, Rumination

41 Rumen inert lipids and glucose precursors lessen prepartum feed intake depression and improve carbohydrate status in periparturient dairy cows. C. E. Sorenson^{*1}, A. R. Hippen¹, D. J. Schingoethe¹, and R. S. Patton², ¹*South Dakota State University, Brookings*, ²*Galisteo, NM*.

In a trial to determine the effects of dietary fat and glucose precursors on ketosis and postpartum health of dairy cows, 24 multiparous Holstein cows were divided into two groups. The treatment group (T) received 0.45 kg/d MetaxerolTM, a specific combination of rumen inert lipid, calcium propionate, propylene glycol, and niacin (Pestell, Inc., Ontario Canada), and the control group (C) received 0.45 kg/d of a 50:50 mixture of calcium salts of fatty acids and ground barley. Treatments were added to the diet from 14 d before until 21 d after calving. Liver samples were collected by puncture biopsy at -14 and -2 d prepartum and at 2, 7, 14 and 28 d postpartum. Blood samples were taken via tail venipuncture immediately prior to each liver biopsy and at -7 d prepartum and 21 d postpartum. Production of milk and milk fat, protein, and lactose were not different. A numerical, but not significant, decrease was observed in milk fat percentage from T cows during the first week of lactation (5.5 vs. 6.4% for T and C, respectively, $P = 0.20$). The DMI for T cows was greater than for C cows during the last week prior to calving (15.4 vs. 13.4 kg/d $P = 0.05$). There was no decrease in DMI for T cows during the prepartum period; whereas DMI of C cows during the last week prepartum decreased by 3.2 kg/d compared with the previous week. Although liver lipid concentrations were numerically decreased in T cows on d 7, differences were not significant (8.1 vs. 9.6% wet wt, $P = 0.17$) and glycogen concentrations of livers did not differ also. The T cows had greater blood glucose concentrations, pre-calving (70.75 vs. 62.1 mg/dl) and post-calving (60.06 vs. 56.24 mg/dl, $P = 0.04$). Accordingly, total number of days of ketosis was less for T cows than for C cows (11 vs. 29 d). Feeding MetaxerolTM for 2 wk before parturition until 3 wk postpartum helped avoid periparturient feed intake depression, increased carbohydrate status as evidenced by increases in blood glucose, and may be beneficial in prevention of ketosis.

Key Words: Periparturient, Ketosis, Fatty Liver

42 Differences in resistance to heat shock between 2-4 cell Brahman and Holstein embryos produced in vivo. C.E. Krininger III^{*1}, J. Block¹, Y.M. Al-Katanani¹, R.M. Rivera¹, C.C. Chase Jr.², and P.J. Hansen¹, ¹*University of Florida, Gainesville*, ²*USDA, ARS, Brooksville, FL*.

Exposure of in vitro produced embryos to elevated culture temperature (heat shock) reduces development. Heat shock effects were greater for Holstein (H) embryos than for Brahman (B) at d 4 after fertilization. Objectives were to test if embryos produced in vivo are susceptible to heat shock, if breed differences in this response exist at the 2-4 cell stage, and to determine breed effects on estrous synchronization and superovulation. Holstein (n=24) and B (n=29) cows with a corpus luteum were injected with 100 µg GnRH (d 0) and 12.5 mg PGF_{2α} (d 7 and d 8). The proportion of cows displaying standing estrus was higher ($P = 0.08$) for H (50 vs 29%) - there was no significant difference for estrus based on tail paint (71 vs 58%). Forty cows detected in estrus were superovulated using FSH. Luteolysis was induced with PGF_{2α} and cows were inseminated 36 and 48 h later using semen from the same breed as the donor. At first insemination, 100 µg GnRH was given. Ten cows of each breed were killed 48 h after GnRH and oviducts flushed. Embryos were cultured for 24 h. Then, 2-4 cell embryos were cultured at either 38.5°C or 41°C for 4.5 h. Thereafter, all embryos were cultured at 38.5°C. There were no breed effects on ovulation rate (16.6 vs 15.2 for H and B, respectively) or embryo recovery rate (69 vs 66%). Cleavage rate (CR) at slaughter was lower ($P \leq 0.001$) for H than B (16±3.5 vs 43±3.8%) but CR at the time 2-4 cell embryos were separated was higher ($P \leq 0.001$) for H than B (74±3.8 vs 63±4.1%). Heat shock reduced development but there were no significant breed by temperature interactions. For example, the proportion of embryos that developed to blastocyst was 16.2±5.0% vs 0.0±4.1% for H at 38.5°C and 41°C, respectively, and 13.05.2% vs 0.0±5.3% for B (temperature, $P \leq 0.05$). In conclusion, 2-4 cell embryos produced in vivo can be disrupted by heat shock. There was no evidence that H embryos were more sensitive to heat shock than B embryos at this stage in development.

Key Words: Breeds, Heat shock, Embryo

On-Farm Certification Programs

43 Auditing procedures. David Meisinger*¹, ¹National Pork Producers Council.

Any certification program must have audits in order to ensure that the product, process or system meets the requirements intended for the program and that they continue to follow these procedures. Audits are intended for control or compliance. This paper will deal with the different types of audits, how they are conducted and who usually conducts them. The procedures used in any audit have been standardized by the American Society of Quality and will be outlined in this paper. These procedures include preparation for the audit including the phases in the process and the steps in preparation. These steps include performance standards and the checklist to be used in the audits. The second phase is performance of the audit including how facts are gathered and how conclusions are reached. The next phase involves reporting of the results in a meeting and in a formal report. The last phase is closure with corrective action and formal closure. This brief presentation will provide attendees with a quick view of these accepted procedures used in auditing for certification purposes.

Key Words: Audits, Quality audits, certification

44 Certification programs on farm animal care issues. John McGlone*, Texas Tech University.

Farm animal care involves both animals at institutions who teach and conduct research (such as universities & companies) and on commercial farms. The public demands – to varying degrees – that farm animals be treated humanely both in publically-funded activities, most notably teaching and research, and in production systems that supply animal products. The main question is not if the public demands will be met, but how best to meet the consumer wants and wishes for humane treatment of farm animals. Animals used in biomedical research are now overseen by an ACUC and a number of checks and balances are in place to assure adequate animal care. These assurances extend to vendors who produce laboratory animals (lab animal “farms”). Furthermore, veterinarians can be board-certified in laboratory animal medicine. Parallel assurances and certifications are only partly in place for farm animals at public institutions and on commercial farms. FASS has recently taken the leadership in developing peer-reviewed animal care training materials. Commodity groups have developed quality assurance programs – most of which lack third-party verification – that often include a small animal care component. ARPAS has an opportunity now to participate in new areas of certification that might include new programs such as (a) institutional professional board certification in farm animal care, (b)

farm animal worker certification, perhaps on at least two levels, and (c) on-farm worker certification.

Key Words: Animal Care, FASS, ARPAS

45 Certification of nutrition professionals. L. E. Chase*¹, ¹Cornell University.

The American Association of Feed Control Officials (AAFCO) has proposed licensing of nutrition professionals. In response to this proposal, the American Registry of Professional Animal Scientists (ARPAS) established a work group to examine this issue and develop a position statement. The work group agreed that the concept of licensing is appropriate. The rationale for licensing should be to provide assurance of professional competency of nutrition professionals. The work group indicated that the licensing process must include measures of knowledge, experience and expertise. It was proposed that an examination process be used as part of the licensing process. This would require development of a new exam. An initial or temporary license could be granted to individuals until the licensing program and exam were fully developed. The work group concluded that a college degree should not be a requirement for obtaining a license. Continuing education credits would also be required to maintain the license. The ARPAS group indicated a willingness to work with AAFCO and others to move this licensing process ahead.

Key Words: Certification, Licensing, Nutrition professionals

46 Verification of good production practices which reduce the risk of exposure of pigs to *Trichinella*. D.G. Pyburn*¹, H.R. Gamble², L.A. Anderson¹, and L.E. Miller¹, ¹USDA, APHIS, VS, ²National Research Council.

Control of *Trichinella* infection in pork has traditionally been accomplished by inspection of individual carcasses at slaughter or by post-slaughter processing to inactivate parasites. Declines in prevalence of this parasite in domestic swine during the last twenty to thirty years coupled with improvements in pork production systems offer the opportunity to document pork safety at the farm level. We report here on a certification pilot study using an on-farm audit to document good production practices for swine relative to the risk of exposure to trichinae. Based on the results, improvements in the program have been made and further studies will be undertaken prior to launching the voluntary *Trichinae* Certification Program in the United States.

Key Words: Pre-harvest Pork Safety, *Trichinae*, Food Safety

Conservation and Management of Animal Genetic Resources

47 Managing Genetic Diversity, Selection and Inbreeding in Livestock. P Bijma*, Wageningen Institute of Animal Sciences (WIAS).

Genetic drift is caused by random sampling of alleles that contribute to the next generation, and results in loss of genetic diversity in populations. There are two sampling processes. First, sampling between families, i.e. some families become parents of the next generation, whereas others don't. Second, Mendelian sampling of alleles within individuals. Without selection, both processes contribute approximately equal to loss of diversity. With selection (e.g. livestock), between family sampling causes the majority of the loss of diversity. Thus maintenance of diversity requires restriction of between family selection. Drift per unit of time is quantified by the variance of gene frequency change that can be attributed to a single generation or cohort, σ_q^2 . Drift causes homozygosity by descent (inbreeding), and drift variance and rate of inbreeding (ΔF) are equivalent measures of the loss of diversity, $\sigma_q^2 = q(1-q)\Delta F$. In livestock, the challenge is to genetically improve populations while maintaining diversity, i.e. to maximize gain (ΔG) while restricting ΔF . The long-term genetic contribution theory reveals a relationship between ΔG and ΔF ; $\Delta G = \Sigma a_i$ and $\Delta F = \Sigma r_i^2$, where r is the long-term genetic contribution of an individual, a is its Mendelian sampling term and the sum is taken over all individuals per unit of time. It follows that the theoretical maximum gain with restricted inbreeding is achieved by a linear increase of r with a . This provides a general

measure of genetic efficiency of selection programs. Selection tools that maximize gain while restricting inbreeding try to establish this linear relationship by determining the optimum contribution of selection candidates to the next generation, which implicitly restricts between family selection. With restricted ΔF , minimum coancestry and factorial mating increase ΔG . In addition, molecular markers enable reduction of Mendelian sampling drift, but benefits are small for livestock. Thus it is technically feasible to maximize ΔG while restricting ΔF . The commercial situation, however, may prohibit this. In particular in dairy cattle, global competition, availability of genetic material, and information on genetic quality (Interbull) causes breeding companies to focus on short-term improvement.

Key Words: Genetic Diversity, Inbreeding, Selection

48 Identification of germplasm for preservation from pedigreed populations. M. D. MacNeil*¹, W. R. Lamberson², and B. L. Golden³, ¹USDA-ARS, Fort Keogh LARRL, Miles City, MT, ²University of Missouri, Columbia, ³Colorado State University, Fort Collins.

Cryogenic conservation programs seek to maximize genetic diversity in the conserved sample of germplasm. Breed associations record and maintain extensive pedigree databases for a wide variety of livestock

populations. The objective of this research was to develop methods for identifying genetically diverse samples of animals from pedigree databases. Candidates for cryopreservation can be initially identified by appropriate criteria. Given the list of candidates and their pedigrees, coefficients of relationship (R) among them can be calculated. For large numbers of candidates, one suitable approach is to generate a list of "pseudo progeny" from all possible pairs of candidates and compute the inbreeding coefficient for each of them. The R for each pair of candidates is then twice the inbreeding coefficient of their pseudo progeny. The R can be used directly as in a procedure proposed for use in swine. That algorithm is initiated with an arbitrary animal or a set of preselected animals (perhaps ones that already have pools of semen available) and sequentially selects the animal with the lowest cumulative relationship to the previous set until a desired complement is attained. This procedure was tested on a simulated set of relationships among 100 animals. Repeated sets of 10 animals were chosen from the population by three methods: 1) random sampling; 2) use of the algorithm initiated with a random seed animal; and 3) use of the algorithm initiated with a set of five random seed animals. The mean of the relationships for the three procedures were: 0.102, 0.067, and 0.076, respectively, and SD were 0.014, 0.005, and 0.006, respectively. Alternatively, the R may be transformed (reciprocal, 1-R, etc.) to distance measures. A cluster analysis procedure can then be used to identify a set of animals for cryopreservation. Alternative distance measures and clustering methods need to be evaluated as does the similarity of outcome using pedigree vs using allelic frequencies at several loci.

Key Words: Genetic Distance, Diversity, Conservation

49 DNA sequence diversity and haplotype relationships at gene loci in U.S. beef cattle populations. M. P. Heaton*, *USDA, ARS, U.S. Meat Animal Research Center.*

Single nucleotide polymorphisms (SNPs) are useful as DNA markers because they occur at a high density in U.S. cattle populations, they are genetically stable over evolutionary time scales, and they are amenable to a variety of high-throughput technologies developed from the Human Genome Project. To capture the breadth of sequence diversity in U.S. beef cattle, a panel of 96 cattle DNA samples was designed for automated DNA sequencing of small amplicons at gene loci. The beef breeds comprise greater than 99% of the germplasm used in the U.S. beef cattle industry, based on the number of registered progeny for each breed. This beef cattle diversity panel (MBCDP2.1) is expected to allow a 95% probability of detecting any allele with a frequency greater than 0.016 in the group. Because the information content of an individual SNP is inherently low (biallelic), the set of SNP alleles residing on a specific segment of a chromosome may be used as a group (i.e., DNA segment haplotype) to discern additional allelic variants and thereby enhance measurements of genetic diversity. Defining the relationships between DNA segment haplotypes allows them to be considered in an evolutionary context and provides an objective means of identifying potentially ancient DNA segments.

50 Cryopreservation of rooster sperm. S.P. Gill*¹ and Guy Barbato², ¹*BioPore Inc, State College, PA.*, ²*The Pennsylvania State University, University Park, PA.*

Cryopreservation of poultry sperm likely can benefit individuals interested in maximizing fertility with sperm from males of lines that are on the verge of extinction or elimination. In the past, fertility of cryopreserved chicken sperm has been unacceptably low, unless impractically high numbers of sperm per insemination and frequent artificial insemination (AI) are combined. There are at least 2 reasons. First, cryoprotectant (e.g., glycerol) must be present at >13% (v/v; 1.8 M) concentration for retention of motility or viability, but has to be reduced to <0.7% (v/v; 0.1 M) before AI due to its contraceptive effect. Second, a protein important in sperm-egg binding is stripped from sperm during cryopreservation and that causes greater reduction in fertility than predicted on the basis of post-thaw sperm motility. Most procedures tried with rooster sperm rely on slow dilution of thawed semen plus centrifugation and resuspension of sperm in a small volume, to reduce glycerol concentration. A new method for cryopreservation uses special containers with major faces formed from "gated-pore" membranes. It allows automated removal of cryoprotectant and circumvents the need for dilution or centrifugation. Sperm from different lines of layers and broilers was frozen with this method. Sixty-seven percent of eggs laid had a viable embryo after AI of only $\sim 170 \times 10^6$ sperm every 4 days. However,

significant differences were observed within lines to the amount of cryoprotectant and fertility. Exposure of thawed rooster sperm to synthetic pro-fertility peptides increased ($P < 0.01$) fertility by 20-40% above that obtained with untreated (control) sperm. Through non-surgical intramaginal insemination, it was possible to obtain some fertility from line whose sperm did not tolerate cryopreservation very well. Rare or experimental lines, whose sperm quality and fertility is exacerbated by cryopreservation can be recovered using intramaginal inseminations and addition of pro-fertility peptides to the thawed sperm before AI.

Key Words: Sperm, Cryopreservation, Intramagnum

51 Preserving/conserving germplasm by incorporating embryo-related technologies. R.S. Prather*, *University of Missouri-Columbia, Columbia, MO.*

Embryo-related technologies, for the purpose of this talk, is defined as any technology that uses the unfertilized egg or early embryo. These technologies may include preservation of sperm, unfertilized eggs, embryos, or cells. Haploid genetic material might be preserved in the form of sperm or unfertilized eggs, while diploid genetic material might be preserved in the form of pre-attachment stage embryos or as cells harvested from live animals. Term development has resulted from cryopreservation of unfertilized eggs followed by fertilization and embryo transfer. Preservation of sperm is no longer limited to cryopreservation, as freeze-dried sperm have been rehydrated and injected into unfertilized eggs. This technology is termed intracytoplasmic sperm injection (ICSI). Nuclear transfer (NT) technology, i.e. the transfer of diploid nuclei to enucleated eggs, has also resulted in the production of offspring. These latter two technologies, ICSI and NT, are dependent upon adequate numbers of mature unfertilized eggs being readily available. While ICSI will permit the production of offspring from half of the desired genotype, NT will result in offspring that are entirely derived from the nucleus of the donor cell. While both of these technologies offer great promise, there are a number of limitations. The first limitation is that large numbers of meiotically mature unfertilized eggs are required. The second limitation is that these eggs influence the entire genetic makeup of the resulting animal. This is because the eggs contain mitochondria that have their own genome. Thus, if there is an incompatibility between the proteins whose production is directed by the nucleus and proteins whose production is directed by the mitochondria, then the resulting embryo could fail to develop, or fail to reproduce the desired phenotype as an adult. A third limitation, observed in cattle, is the production of animals that fail to thrive, and up to half die during the first few weeks postnatally. When considering the use of such technology, one should remember that phenotype is directed by both genetic makeup and environment.

Key Words: Cloning, Nuclear Transfer, Embryo-Technologies

52 Conservation and preservation of poultry genetic resources: a review of issues and progress. Mary Delany*, *University of California, Davis CA 95616.*

The landscape of extant poultry genetic resources is complex and thus considerations for conservation and preservation are complicated by a number of interwoven issues. Issues for consideration include but are not limited to: (1) the variety of species, (2) the types of populations, (3) the heterogeneity of purposes, (4) inherent difficulty in predicting future utility and needs, (5) financial resources, (6) paucity of genetic diversity assessment, (7) only the male germplasm can be cryopreserved. We know that (1) hundreds of research genetic lines have been eliminated over the last two decades and such elimination is ongoing, (2) the number of independent primary breeder companies has declined through industry mergers and anecdotal discussion indicates entire groups of lines are often dropped in the process, (3) several recent molecular genetic studies suggest reduced diversity for industry White-Leghorn based populations, (4) U.S. poultry breed population status is currently unknown although assessment is underway by the American Livestock Breeds Conservancy. The National Animal Germplasm Program poultry species committee consists of academic, industry and government geneticists, researchers and administrators committed to improving the status quo of poultry genetic resources. Many of the committee members are directly involved in maintaining and managing poultry genetic resources. Committee work during the last 12 months focused on assessing what our committees' priorities should be and the two top areas include promotion of cryopreservation research and preservation of living-stocks

collections. In regard to the latter, a recognition letter has been designed to alert university-based administrators of the value of poultry genetic resources. The committees' present administrative goals include development of priority guidelines for repository deposits of semen at the Ft. Collins NAGP facility, development of poultry-specific parameters for the GRIN database, establishment and distribution of useful guidelines/advice for handling and cryopreservation of semen by non-experts.

Key Words: Poultry, Conservation, Genetic resources

53 Dairy cattle contributions to the National Animal Germplasm Program. L. B. Hansen*, *University of Minnesota, St. Paul.*

Genetic diversity within the six recognized breeds of dairy cattle in the US was viewed as the key area of concern for the dairy cattle committee of the National Animal Germplasm Program. The ten-member dairy

cattle committee has a membership roster as follows: two from the land-grant universities (L. Hansen, U. of MN, Chair, and M. Schutz, Purdue U.), two from USDA/ARS (M. Ashwell and C. Van Tassell), two from AI companies (D. Funk, ABS Global, and C. Sattler, Select Sires), one from NAAB (to be named), one from a breed association (C. Wolfe, American Jersey Association), the USDA/ARS Executive Secretary for NAGP (H. Blackburn), and an ex officio member from USDA/CSREES (R. Frahm). Committee members will have terms with fixed years of service, and the terms will have staggered years for final year of service. The key goal of the dairy committee is for each A.I. organization in the US to submit 30 units of frozen semen from progeny test sires to the repository for the germplasm program at Ft. Collins, CO. Frozen semen is requested from each 10th Holstein sire entering progeny testing as well as every bull entering progeny test for the other five breeds. The dairy cattle committee will be charged with the responsibility of reviewing requests for use of dairy cattle germplasm in the repository.

Key Words: Germplasm preservation, Dairy cattle, Genetics

Energy Nutrition of Ruminants

54 Energy nutrition of ruminants: keeping books. C.L. Ferrell*, *USDA, ARS, Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE.*

Goals of energy metabolism research with ruminants have historically been to 1) develop an accurate means for evaluating feedstuffs and stating animal requirements, and 2) establish the tissue and biochemical origin of heat production or energy expenditures. Techniques employed in nutritional energetics of ruminants have classically been concerned with the partitioning of dietary energy into fecal, urinary, methane, heat, and recovered or product energy. Attributes of feeds that influence the partition of dietary energy has received limited attention recently. Indirect respiration calorimetry and comparative slaughter techniques continue to be important energetics research tools. Carbon dioxide entry rate techniques have found application in goat, sheep, and cattle studies. The use of heart rate as an index of energy expenditure may have application to the free ranging animal. Techniques utilizing blood flow, thermal dilution and gas analyses to quantify and separate heat generated from the GI tract into aerobic and anaerobic origins has been successfully applied to ruminants. Assessment of tissue energy metabolism from blood flow and substrate flux across the PDV, liver, gravid uterus, fetus, mammary gland, and hind limb have contributed substantially to our understanding of tissue energy expenditures and sources of their variation. Studies at the organ, tissue, cellular, and subcellular levels, including substrate turnover and channeling, ion transport, proton leakage, and uncoupling proteins have increased our understanding of the biochemical processes involved. Regulation of those processes through hormonal and other means is beginning to be understood. A major challenge of the future lies in not only establishing the biological and biochemical bases for energy expenditures, but also in determining the genetic and biological bases for differences among animals. It is equally critical that we be able to translate fundamental knowledge gained through these endeavors to functional understanding that can be applied to the whole animal.

Key Words: Cattle, Heat, Energy metabolism

55 Economics of visceral nutrient metabolism in ruminants - toll keeping or internal revenue service? C. K. Reynolds*, *The University of Reading, UK.*

Measurements across a range of productive states show that the portal-drained viscera (PDV) and liver, or the total splanchnic tissues, account for 40 to 50 % of body oxygen consumption or heat. This high rate of metabolism is in part attributable to high rates of protein turnover and thus amino acid utilization, as well as other 'service' functions supporting nutrient assimilation and 'waste management'. This metabolic intensity and the anatomic position of absorptive and liver tissues has led to the assumption that the tissues that assimilate and process incoming nutrients from the diet exact a toll in payment for their entry. This 'toll' is believed to reduce the extent to which absorbed nutrients gain admission to the arterial blood pool and reach 'productive' organs such as the mammary gland or skeletal muscle. Measurements of net nutrient flux generally support this concept of splanchnic metabolism 'restricting entry' and thus dictating supply, as on a net basis the appearance of the major carbon-based nutrients absorbed into the portal

vein is typically low compared to their rate of disappearance from the gut lumen. An alternative interpretation is that this low net recovery of absorbed nutrients across splanchnic tissues is attributable to extensive metabolism of nutrients from the arterial pool, which masks true rates of absorption. In this scenario any tax to support community services is paid using internal funds. Measurements of nutrient kinetics based on isotopic labelling support the latter scenario. In the case of the liver, catabolism of amino acids is driven in part by supply and demand, with over-population dealt with by depopulation, restructuring or the metabolic equivalent of cremation. Similarly, relative rates of amino acid metabolism by the gut and mammary gland vary with requirement. Organ metabolism of many energy-yielding nutrients varies with supply, demand and the need for waste management and other community services.

Key Words: Organ metabolism, Energy, Amino acids

56 Endocrine and gene expression profiles in relation to energy metabolism. G. Murdoch¹, W.D. Dixon¹, V.E. Baracos¹, E.K. Okine¹, D. Balcezak¹, J.A. Moibi¹, B.T. Li¹, R.J. Christopherson^{*1}, and R.J. Christopherson¹, ¹*University of Alberta, Edmonton, Canada, T6G 2P5.*

In order to test hypotheses regarding regulation of energy metabolism, heat production (HP) was examined in response to adrenergic agonists and/or blocking agents in ruminants. Low doses of adrenaline, acting via β adrenoceptors, increases HP ($P < .05$) in cattle (40%) and in sheep (30-45%). Increases in HP of sheep in response to adrenaline averaged 32% ($P < .05$) while increases in the portal drained viscera and hindquarter metabolic rates were 50 % ($P < .05$) and 61 % ($P < .05$) respectively and were abolished by beta adrenergic blockade. Increases in whole body and hindquarter HP during acute cold exposure were reduced by 20-50 % by β blockers. Alpha-2 selective agonists suppress heat production in ruminants by 20-23 % ($P < .05$), suggesting a role in energy conservation. HP was positively related to β receptor density in the heart muscle, but a negative relationship was observed in non-cardiac tissues. Lipogenic enzymes (ACC and FAS), in subcutaneous and mesenteric adipose were positively correlated ($P < .05$) to HP. Expression of other target genes have recently been determined in skeletal muscle, adipose depots, rumen, abomasum and duodenum in cattle, using PCR. The expression of leptin receptor and NPY receptor type II genes were correlated ($P < .05$) in peripheral tissues, such as Biceps femoris ($r=0.91$) and subcutaneous adipose ($r=0.70$). These were not as well correlated in mesenteric adipose and perirenal adipose. Receptor gene expression was not detected in GI tissues. The expression levels of UCP1, UCP2, and UCP3 in tissues that we have screened using RT-PCR, ranged from undetectable to 100 densitometric units. We observed variable expression of leptin mRNA in adipose depots which may pertain to various functions of this peptide. Positive correlations between HP and urinary excretion of 3-MH ($P < .39$) and hydroxyproline ($P < .51$) paralleled changes in expression of genes for proteolytic enzymes. Compilation of information relating to the expression of specific genes

linked to energy expenditure will help elucidate the physiological basis for variations in energetic efficiency.

Key Words: Endocrines/Genes, Energy Metabolism, Ruminants

57 Cellular energy expenditure and the importance of uncoupling. M-E. Harper*¹, A. Antoniou¹, V. Bezaire¹, and S. Monemdjou¹, ¹*University of Ottawa.*

Just as total body energy expenditure in animals can be classified into that which supports resting energy metabolism, work, growth, etc., cellular energy expenditure can similarly be classified. Our overall objective is to examine the metabolic origins of cellular energy expenditure, differentiating between metabolic states where cells are at relative rest, and where cellular energy expenditure is high. In most situations when energy expenditure is high, mitochondrial ATP production (oxidative phosphorylation) is coupled and efficient. Uncoupling refers to the dissociation of the oxidation of energy substrates, such as fatty acids, from the synthesis of ATP by mitochondria. Uncoupling can occur during

states of high energy expenditure or during states of metabolic rest. In brown adipocytes, uncoupling protein 1 (UCP1) activity can cause very high rates of energy expenditure for the purpose of thermogenesis (heat production). UCP1 is found exclusively in brown adipocytes. While uncoupling also occurs in other cells of the body, it is of greatest importance during periods of relative metabolic rest. The latter form of uncoupling is referred to as mitochondrial proton leak, and accounts for roughly one quarter of the resting metabolic rate of the rat. The mechanisms of mitochondrial proton leak are not well understood. The recently identified uncoupling proteins may play some role, but may also have some other physiological functions. Our recent findings from transgenic mice with altered expression of UCPs will be reviewed. Proton leak activity scales roughly in proportion with metabolic rate in mammals of different body size, and is related to thyroid hormone status. Proposed functions for mitochondrial uncoupling include thermogenesis, control of oxidative phosphorylation efficiency and protection from reactive oxygen species. Support: NSERC of Canada.

Key Words: thermogenesis, proton leak, uncoupling

Meat Science in an International Marketplace

58 Global meat research initiatives. R.B. Sleeth*¹, ¹*Consultant.*

The International Congress of Meat Science and Technology (ICoMST) is a very extraordinary and dynamic organization. A brief review will highlight the history, structure, and function to enable participants to better understand and appreciate its uniqueness as a scientific entity. It is imperative that we foster worldwide cooperation in meat science and technology research to be better informed and to minimize duplication. Within the USA, scientists access the Current Research Information System (CRIS) to determine the status of ongoing research. One purpose of the ICoMST is to provide a global forum for discussing research concepts and accomplishments but proceedings are not available for the majority of the scientific community. The presentation will briefly highlight related meat research programs from several countries which hopefully will provide the impetus to develop an implementation plan to foster greater worldwide exchange of meat science and technology.

59 U.S. Pork Products in the International Marketplace. J.W. Cravens*, *National Pork Producers Council, Des Moines, Iowa.*

In 2000, the United States exported 1.25 billion pounds of pork and pork variety meats, worth 1.316 billion dollars, an increase of 213 percent by volume and 224 percent in value since 1991. Exports now represent 6.8 percent of domestic production. According to the USDA Foreign Agriculture Service, pork represented 41 percent of global meat protein consumption in 1999. Global pork trade is projected to continue increasing as global populations and per capita incomes increase and trade barriers fall.

Although the United States is one of the world's lowest cost producers of pork, to maintain rapid growth in exports, the United States industry must continue to supply safe, high quality pork that meets the needs of varied customers around the globe. The demands of the export market can vary significantly from those of the U.S. market. The United States exported pork or pork variety meats to 85 different countries in 2000.

Frequently the demand for various pork cuts or byproducts are unique to these individual markets. And just as frequently, unique requirements or standards exist in areas such as processing, carcass fabrication, labeling, food safety, sanitation and hygiene. This presentation will look at the demands of the export market for U.S. Pork and explore a number of these issues. It will contrast the specifications and customer requirements in the domestic market with those of the export market in an attempt to present both the opportunities that exist for increasing exports and the barriers that must be overcome. It will also explore some of the advantages our competitors have over the U.S. industry.

Key Words: Pork, Exports, Trade, Variety meats, Offals

60 Poultry products and processing in the international marketplace. S.F. Bilgili*¹, ¹*Auburn University.*

Globally, consumption of poultry meat products has increased dramatically during the last decade. As a result, production of young meat chickens (broilers), turkeys and other poultry (spent layers, ducks, geese, guinea-fowl, pheasants, ratites, etc.) continues to grow and expand in many parts of the world. Nutritional profile, taste, versatility, convenience, availability and relative value are the major reasons why consumers prefer poultry meat products. Adoption of new production and processing systems and technologies, and development of new and novel products have enabled the poultry industry to continually innovate and respond to market demands. Although poultry products vary greatly in many countries, ranging from live poultry markets to consumer packaged, ready-to-eat entrees, there has been a clear trend of diversification in the marketplace. The most obvious change has been the steady shift in product forms, from a primarily "homogenous, generic commodity" to a "well differentiated, name-branded, value-added" products. Value-adding by cut-up and further-processing not only meets the changing needs of the consumers, but also improves the net returns and profitability. Given this trend, the future challenge in product development will be preservation and/or incorporation of unique cuisine and preferences of diverse cultures.

ASAS/ADSA Animal Behavior and Well Being

61 Effect of genetic selection for loin-eye area on belly-nosing and plasma cortisol in weanling Landrace pigs. S. Torrey*¹, E. Pajor¹, S. Weaver², D. Kuhlers³, and T. Stewart¹, ¹*Purdue University*, ²*USDA-ARS Livestock Behavior Research Unit*, ³*Auburn University.*

Two genetic lines of Landrace gilts, selected for differences in loin-eye area, were studied for behavioral and physiological differences during Segregated Early Weaning (SEW). The select line, selected for increased loin-eye area (n = 30), differed from the contemporary random control line (n = 32) by 10.6 cm². The gilts were weaned at an average age of 15 d and transported from Auburn University to Purdue University. Litters were blocked by farrowing date to minimize age differences and trans-

ported on two dates, 2 wk apart. Litters were videotaped continuously while in nursery to record frequency of belly-nosing. Individual blood samples were collected in late afternoon 9, 20 and 30 d after arrival into the SEW facility to measure plasma cortisol levels. Frequency of belly-nosing was examined on d 2, 3 and 4 post-weaning using scan sampling. Significant differences in frequency of belly-nosing were seen only on d 4 between the two lines (select 2.43 ± 0.44% of time; control 0.61 ± 0.43% of time; p < .02). This is in agreement with previous literature that found differences in belly-nosing occurring several days after weaning. Blood samples were assayed for cortisol levels using GammaCoat RIA. Cortisol concentrations in the select pigs (29.34 ± 3.12 ng/ml) were significantly higher (p < .02) than in the control pigs (23.11 ± 3.00 ng/mL). Previous results showed that the select pigs spent more time active and

had higher whole blood serotonin levels than control pigs. Our results suggest that a genetic relationship exists for lean pigs with an increased loin-eye area and a pig's ability to handle the stress of weaning. As weaning is a stressful event in a pig's life, this decreased ability to handle the stress related to weaning may have negative implications on the welfare of pigs selected for lean growth.

Key Words: belly-nosing, cortisol, genetics

62 Savaging in gilts and second parity sows: a study of seven commercial farms. M.J. Harris^{*1,2,3}, Y. Li¹, and H.W. Gonyou¹, ¹*Prairie Swine Centre Inc., Saskatoon, Saskatchewan, Canada*, ²*University of Saskatchewan, Saskatoon, Saskatchewan, Canada*, ³*Present address: Purdue University, West Lafayette, Indiana, USA.*

Savaging of piglets by their mothers is a harmful and costly behavior, the extent and causes of which are largely unknown. A study was conducted to investigate the incidence and correlates of savaging behavior on seven new 600- or 2400-sow units (n = 4 and 3, respectively) during their first two farrowing cycles. Females were subject to a light (continuous or intermittent light) and sound (newborn piglet vocalizations or no vocalizations) treatment before and during farrowing. Behavior records were collected for the first farrowing of 6625 gilts (first farrowing cycle) and 2175 gilts and 5232 sows (second cycle). The incidence of savaging and number of piglets killed or injured by it were recorded.

During the first farrowing cycle 331 gilts (5.3%) displayed some piglet-directed aggression, and of these, 201 (2.9%) fatally savaged one or more of their young; 392 piglets (.6%) were killed by savaging and a further 114 (.14%) were non-fatally injured. Savaging levels were similar for the gilts in the second farrowing cycle, while the problems were reduced to approximately half among the sows. During the second parity, females that had savaged as gilts were more likely to behave aggressively again (14%) than those that had not (<1%; p<0.05). There was considerable variation among farms in reported incidence of savaging and numbers of piglets affected. During the first farrowing cycle, percentages of gilts killing one or more of their offspring ranged from .8% to 5.8%, and percentages of piglets killed by savaging ranged from .1%-1.1%.

During the first farrowing cycle, continuous light resulted in a reduction in the proportion of piglets fatally savaged (.47 vs. .77%; p<0.05) and reduced total reported mortality (.62 vs. .74 piglets/litter; p<0.05) compared to intermittent light. Gilts farrowing in crates in the center of rooms receiving the vocalization playback fatally savaged more piglets (.12 piglets/litter) than did those in the front (.05 piglets/litter) or back (.07 piglets/litter; p<0.05). We theorize that increased illumination allowed gilts to better see approaching piglets, reducing their fear response. The sound treatment may have disturbed the gilts, and thus extraneous sounds should be minimized during farrowing.

Key Words: Pig, Savaging, Mortality

63 Behavior of outdoor sows 72 h after parturition: relation to piglet mortality. A. K. Johnson^{*1}, J. L. Morrow², J. W. Dailey², and J. J. McGlone¹, ¹*Pork Industry Institute, Texas Tech University, Lubbock, TX, 79409-2141*, ²*USDA-ARS, TTU, Lubbock, TX, 79409-2141.*

The majority of piglet deaths occur in the first 72 h after parturition, with the main cause attributed to crushing by the sow. The objectives of this study were to determine 1) time spent outside the farrowing hut by the sow and 2) sow behavior one hour prior to the piglet death in relation to piglet mortality. Records were used to identify PIC USA sows that crushed (CR) N=10 or did not crush (NC) N=10 piglets and for these sows the time spent inside and outside the hut was determined. Records from 10 of these sows (N=5 CR and N=5 NC) were used for further behavioral analysis. Sows were housed in an English style-farrowing hut with chopped wheat straw bedding and a metal fender. Multiparous sows were fed a completely balanced milo-soy diet once daily. Behavioral data were collected by time-lapse video using 2.5 frames/s. Nine behaviors were collected: walk, stand, sit, lateral lying, sternum lying, lying while rooting, stand while rooting, nurse and outside of the farrowing hut. Sows did not differ in the amount of time spent outside the farrowing hut (P > .05) over the first two days. On day three, CR spent less (P < .01) time than NC outside of the hut (20.2 4.7 vs. 40.4 4.8 min/d) and showed an increased (P < .01) time lying on their sternum (9.7 3.1 vs. 0.7 3.1 min/h). Before crushing a piglet, 78 % of the CR were lying on their side and 56 % moved from lying on their sternum to

lying on their side. Only 11 % of NC showed these sequences of behavior with 67 % nursing, then remaining on their side. In conclusion, CR sows spent more time inside the farrowing hut on day three and spent more time lying on their sternum. The behavioral sequence associated with crushing piglets was a shift in lying postures rather than transitions from sitting or standing to lying down.

Key Words: Piglet, Behavior, Mortality

64 The lying behavior of pigs; a basic study. E.D. Ekkel¹, H.A.M. Spoolder², and B. Hulsege³, ¹*Wageningen University, Wageningen, The Netherlands*, ²*Research Institute for Animal Husbandry, Lelystad, The Netherlands*, ³*ID-Lelystad, Lelystad, The Netherlands.*

An experiment was carried out in which the lying behavior of pigs was studied. It is well known that pigs housed in groups prefer to lie down together for many hours per day, but little is known about their lying posture and the total space they occupy. Moreover, the extent to which pigs tend to huddle was studied, since this affects their total space occupation. Information about these lying characteristics is necessary in order to be able to assess the space requirements for pigs, e.g. in the event (inter)national authorities pass legislation on minimum space requirements for pigs. The study included two replicates of 8 groups. Each group consisted of 8 pigs. Pigs were housed at thermoneutral conditions in 8 m² pens. Two types of flooring were studied: pens with 60 % solid sloped floor and 40 % slatted floor and pens with 60 % solid arched floor and 40 % slatted floor. Lights were on from 0630 until 1830. Feed and water were available ad libitum. Behavior of the pigs was recorded for 48 h on video at approximate 30, 50, 80 and 100 kg live weight. General activity (lying, sitting, standing), lying posture (sternum, half-sternum, lateral recumbent) and percentage of space-sharing (as a consequence of huddling behavior) were scored by 20 min scan-sampling. The results confirmed that pigs lie down for a great part of the day. During the behavioral period, on average > 80 % of the pigs lie down. There were no differences (P > .05) between replicates or floor types. The weight category did affect the lying behavior of the pigs (P = .027): the percentage of pigs that lie down, increased with weight. During the night (1840 to 0620), the fully lateral recumbent lying posture was predominant and unaffected (P > .05) by floor type. A significant interaction was found between replicate and weight category. The percentage of space that is shared with other pigs was on average 33.7, 28.1, 28.3 and 31.0 for 30, 50, 80 and 100 kg pigs respectively. Average space occupation for these weight categories when lying was 0.30, 0.46, 0.64, 0.76 m² per pig. In conclusion, pigs lie down for most of the time and the fully lateral recumbent position is predominant. Regulations for minimum space requirements for pigs should take this into account.

Key Words: Pigs, Lying Behavior, Space requirements

65 Effects of transportation and relocation on plasma glucose, triglyceride and cortisol concentrations in Brahman and Hereford steers. R. Browning, Jr., T. Payton, N. Whittingham, and C. Bradley, *Tennessee State University.*

In Exp 1, Hereford (n = 7) and Brahman (n = 7) steers were hauled round trip (344 km, 243 min) or maintained in holding pens on the farm in a crossover design to assess physiological responses to transportation. Steers were bled on afternoons 6 and 3 d before treatment, immediately after treatment, and 1, 3, and 6 d after treatment. Plasma was harvested to determine glucose, triglyceride and cortisol concentrations. No breed × treatment × day interactions were evident. Treatment × day interaction affected (P < 0.05) all three blood constituents. Glucose, triglyceride and cortisol concentrations immediately after transportation (81 ± 2 mg/dL, 52.4 ± 0.8 mg/dL, and 174 ± 14 ng/mL) differed (P < 0.01) from concentrations at 3 d before (57, 57 and 72) and 1 d after transportation (59, 55 and 61) and compared to non-transported steers (62, 56 and 92). In Exp 2, Hereford (n = 7) and Brahman (n = 7) steers were hauled one-way (55 km, 40 min) to a new farm or hauled round trip an equal distance in a crossover design to assess physiological responses to relocation. Relocated steers were maintained at the new farm for 6 d. Steers were bled on afternoons 6 and 3 d before transit, immediately after transit, and 1, 3, and 6 d after transit. Plasma was harvested to determine glucose, triglyceride and cortisol concentrations. No breed × treatment × day or treatment × day interactions were evident that would have indicated an influence of relocation. Day affected (P < 0.01) all three blood constituents. Glucose, triglyceride

and cortisol concentrations immediately after transportation (88 ± 2 mg/dL, 43.9 ± 0.4 mg/dL and 407 ± 15 ng/mL) were higher ($P < 0.01$) compared to 3 d before (65, 47.0 and 94) and 1 d after transportation (66, 45.4 and 126). Results indicate that plasma glucose and cortisol increased, whereas triglyceride concentrations were reduced in response to transportation in steers. However, the responses were transient and not influenced by breed or relocation.

Key Words: Cattle Breeds, Transportation, Stress

66 Shade effects on performance, carcass traits, and behavior of heat-stressed feedlot cattle. F. M. Mithlner*, M. L. Galyean, and J. J. McGlone, *Texas Tech University*.

In earlier studies on heat stress in feedlot cattle, we found that the use of water (sprinkling or misting) was largely ineffective, but shade minimized some negative effects of heat stress. Past studies were conducted in concrete floored pens under experimental feedlot conditions. To determine whether shade also improves performance, physiology, and carcass traits under conditions similar to those in commercial feedlots, we used a total of 168 heifers in 12 dirt-floored pens. Six pens were shaded (SHADE) with a tin-roofed shade construction (4 m height), allowing for 2.04 m² shade per heifer and six pens served as the unshaded control (CONT). The performance variables that were measured or calculated were DMI, BW, ADG, feed:gain (F:G), and dietary concentrations of NEm, and NEg. Carcass measurements were yield grade, kidney, pelvic, and heart fat, longissimus muscle area, hot carcass weight, quality grade, liver abscess rate, and incidence of dark cutters. The respiration rates of the heifers were measured, as well as the behaviors of feeding, drinking, walking, standing, lying, agonistic, and bulling. Heifers in SHADE compared with CONT had higher DMI (9.80 vs 9.52 ± 0.05 kg/d, $P < 0.01$), ADG (1.74 vs 1.64 ± 0.03 kg/d, $P < 0.05$), and final BW (565.47 vs 554.15 ± 2.97 kg, $P < 0.05$). The F:G, and NEm and NEg concentrations did not differ between treatments. Carcass traits were similar between treatments, but more carcasses of heifers in SHADE graded Choice, (55.84 vs 36.23% , $P < 0.01$) and the incidence of dark cutters (8.33 vs. 19.05% , $P < 0.05$) was decreased in carcasses from SHADE heifers. Respiration rates were decreased among SHADE compared with CONT heifers (73.8 vs 105.3 ± 1.2 breaths/min, $P < 0.01$). Most behaviors were not different between treatments, but cattle in SHADE showed less agonistic behavior than CONT heifers (0.34 vs $1.40 \pm 0.33\%$, $P < 0.05$). During heat, shade improves well-being of feedlot cattle and the profitability of the operation in West Texas.

Key Words: Feedlot Cattle, Heat Stress, Shade

67 Behavioral and adrenal response of cows tail docked with a rubber ring with or without local anesthesia. D. S. Schreiner* and P. L. Ruegg, *University of Wisconsin, Madison*.

The practice of tail docking dairy cattle is controversial. Dairy farmers justify tail docking by claiming it improves cleanliness and reduces mastitis. Behavioral and physiological effects of tail docking are unknown. The objective of this study was to determine the behavioral and hormonal affects of tail docking with rubber rings in dairy cattle. Twenty-four pregnant Holstein heifers 20-25 months of age were randomly assigned to four treatment groups: control, rubber ring docked, control plus epidural, or rubber ring docked plus epidural. Docked animals were banded three to four inches below the vulva. Blood samples were obtained -45, -15, 0, 15, 30, 60, 90, 120, 180, 240, 360 and 720 minutes from treatment for cortisol analysis. Blood samples were obtained at -45 minutes and 7, 14 and 21 days for complete blood count (CBC). Animals were observed -60, -45, -30, -15, -1 before treatment and every 5 min. for the first hour, every 15 min. for hours 2-4 and every 30 min. for hours 5-12 after treatment. Additional behavioral observations were taken three times daily for weeks 1 and 2, twice daily for weeks 3 and 4, and once daily for weeks 5 and 6. Animals were observed for the following behaviors: eat, ruminate, standing, walking, tail shake, vocalization, foot stomping, grinding teeth, posture, restlessness, and tail tucking. There were no significant differences in cortisol levels between treatment groups ($P = .49$). CBC results remained in normal ranges for all animals during all time periods. There were no significant differences in the proportions of behaviors observed between treatment groups ($P > .14$). Tail shaking was observed more frequently for both docked and control animals before and after treatment as compared to other time periods ($P < .01$). The application of rubber rings and the process of

tail atrophy did not significantly affect observed patterns of behavior or selected physiologic variables during the period of this study.

Key Words: Behavior, Docking, Stress

68 Development of a bovine lameness index that correlates visual lameness scores to measurable limb movement variables - a pilot study. P. G. Rajkondawar*¹, N. Neerchal¹, M. A. Varner², B. Erez², A. M. Lefcourt³, R. M. Dyer⁴, and U. Tasch¹, ¹UMBC, ²UM, ³Biomedical Engineer, ⁴Univ of Delaware.

Lameness in dairy herds has been reported to be a critical economic factor and a vital animal-welfare issue for the dairy industry around the world. Various lameness evaluation schemes that assess the severity of the ailment have been suggested. These schemes are based on visual observations of individual cattle. A lameness scoring scale that focuses on the shape of the cattle's back in posture and gait has been proposed. This scheme is easy to implement under field conditions, however it is observer dependent and non-quantitative in nature.

In an effort to objectively characterize the status of hoof and leg ailments, a system that measures various limb movement characteristics was developed. This system can be used to measure multiple variables representative of limb movements, including: (a) peak value of ground reaction force (GRF) of individual limbs, (b) integral of GRF with respect to time, (c) stance time, (d) average GRF, (e) step size, (f) integral of the Fourier transformation of the GRF signature with respect to frequency, and (g) the integral with respect to frequency of the Fourier transform of the GRF signature multiplied by the frequency. To allow comparisons among different cows, variables were normalized with respect to body weight. The objective of this study was to examine the relationship between a visual scoring scale and the 7 listed limb movement variables. The visual lameness score and all movement variables were measured for 23 mature Holstein cows.

Logistic regression and discriminant analyses (LOGISTIC, STEPDISC procedures in SAS) indicate that visual lameness scoring scale can be captured by the average GRF values ($p < 0.05$) of individual limbs. The model predicts probabilities that a cow is sound, mildly lame, and lame. An estimated lameness index is derived as the weighted sum of these probabilities. In this pilot study, the results of the visual scoring scale and the new lameness index matched for lame cows. However the visual scores and lameness index of 6 out of 16 mildly lame and sound cases exhibited discrepancies. Future studies will compare visual scores, limb movement variables, and clinical lameness diagnoses of individual limbs to enhance objective measures of dairy cow lameness.

Key Words: Lameness, Dairy Cattle, Limb Movement Variables

69 Utilization of a small animal model of fescue toxicosis to evaluate the potential benefit of *Ascophyllum nodosum*. P. A. Eichen*¹, D. E. Spiers¹, G. Rottinghaus¹, and D. P. Colling², ¹University of Missouri, Columbia, MO, ²Land O'Lakes Farmland Feed, Kansas City, MO.

Cattle grazing endophyte-infected tall fescue (EIF) during summer months display symptoms of fescue toxicosis that include hyperthermia, decreased feed intake and growth, and death in extreme cases. An economical rat model of fescue toxicosis shows changes in internal body temperature, feed intake and weight gain that are similar to those seen in cattle fed EIF. Adding seaweed extract (*Ascophyllum nodosum*; SWE) to the diet may reduce stress associated with EIF consumption during summer heat. An initial study was performed to determine a level of SWE (range of 0 to 2% of diet) that might reduce symptoms of fescue toxicosis in male rats ($n=36$) fed control or EIF diets ($90\mu\text{g}$ ergovaline/kg BW). Telemetric temperature transmitters (Mini Mitter, Bend, OR) were implanted into one of the 3 rats from each of the 12 treatment groups to measure core body temperature (Tc). Rats were housed at 21°C for 5 days and then heat-challenged (HC) at 31°C for 21 days. Rats fed diets containing more than 0.25% SWE tended to have a lower Tc during initial HC at about 3 days. A second, shorter study was conducted to verify the thermal-relief effect of SWE, using control and EIF diets from Study 1, and SWE (0 or 1% of diet). Rats fed EIF diet with 1% SWE exhibited lower Tc ($P < .0001$) during HC. In both studies, EIF-fed rats had a larger decrease in feed intake ($P < .0001$ and $.0007$) and a smaller gain in body weight ($P < .0001$) than control rats. Decreased blood levels of cholesterol ($P < .002$ and $.03$), alkaline phosphatase ($P < .0001$ and $.009$) and amylase ($P < .002$ and $.01$), together with reduced liver weight ($P < .0001$), were seen in EIF-fed rats in both

studies, with no effect of SWE treatment. Although SWE, at 1% of diet, is effective in reducing the hyperthermia associated with fescue toxicosis, it does not appear to reverse other known disorders associated with fescue toxicosis.

Key Words: Fescue toxicosis, Heat stress, Seaweed

70 Use of *Ascophyllum nodosum* to reduce problems associated with fescue toxicosis in cattle during heat challenge. M. J. Leonard^{*1}, D. E. Spiers¹, G. Rottinghaus¹, and D. P. Colling², ¹University of Missouri, Columbia, MO, ²Land O'Lakes Farmland Feed, Kansas City, MO.

Cattle grazing endophyte-infected tall fescue (EIF) during summer months are at increased risk of heat-related stress. Previous studies have reported that cattle grazed on EIF pastures sprayed with seaweed extract (*Ascophyllum nodosum*) (SWE) exhibit reduced internal temperature compared to cattle grazing EIF pastures without the SWE. The objective of this study was to determine if supplemental SWE would reduce symptoms of fescue toxicosis in cattle. Twelve Angus x Simmental steers (238±10 kg) were randomly divided into 3 treatment groups consisting of 0, 0.5, or 1% SWE. Steers were housed in environmental chambers with a feedlot starter diet and water *ad libitum*. Air temperature and percent relative humidity (%RH) were recorded continuously. Steers were exposed to thermoneutral conditions (19°C, 50% RH, days 1-5 and 27-31) and heat challenge (HC) (26-33°C, 50% RH, days 6-26) during the trial. EIF seed and SWE were fed daily in the diet at a concentration that would ensure 10µg ergovaline/kg BW/day and the appropriate SWE dose. Rectal temperature, respiration rate, and skin temperatures were recorded three times daily to monitor thermal status. Feed intake was recorded daily. Blood was drawn prior to treatment and weekly thereafter for analysis of blood constituents. Feed intakes were reduced during HC for all treatments; however, this reduction was greater for 1% SWE steers (P <0.05). Rectal temperature for 1% SWE was also lower than the other treatments (P <0.05). Respiration rates and skin temperatures were similar for both 0.5 and 1% SWE groups, however, respiration rates for 1% SWE steers were lower than 0% SWE (P <0.05). Blood levels of total and free triiodothyronine and total thyroxine were lower in 1% SWE steers after removal from heat challenge (P < 0.05). Addition of 1% SWE reduced heat-related stress in steers. Further studies are needed to determine the effect of SWE on metabolic function during long-term heat challenge.

Key Words: Fescue toxicosis, Heat stress, Cattle

71 Effects of an intermittent altrenogest regimen on behavioral, hormonal, and testicular parameters of three-year-old stallions. H.A. Vartorella^{*1}, H.A. Brady¹, A.D. Herring¹, S.D. Prien¹, N.L. Heninger¹, and A.L. Neumann¹, ¹Texas Tech University, Dept. of Animal Science and Food Technology.

Overly sexual/aggressive stallions within the performance horse industry create a hazardous working environment and several training challenges. To suppress these behaviors without surgical castration, oral altrenogest (Regu-Mate[®], Intervet, Millbro, DE) is being administered to stallions by trainers in an off-label application. Previous research has studied the use of altrenogest in continuous application. The objective of this study was to evaluate the testicular, hormonal, and behavioral capacity of three-year-old stallions receiving a short term, repetitive dosage of oral altrenogest. Nine, three-year-old Quarter Horse stallions were initially blocked by sire, and then randomly designated to two groups, treatment (n=5) and control (n=4). The treatment group received an oral daily 0.088 mg/kg BW dose of Regu-Mate[®] for 10 d, followed by 10 d of recuperation (no treatment). This process was repeated three times over 60 d, followed by a recovery period of 36 d. All animals went through interval evaluations for steroid hormones, physical condition, testicular parameters, and sexual/aggressive behavior (including Flehmen response, biting/chewing, sniffing/licking, erection of penis, dropping of penis, and vocalizations). The altrenogest dosages had no significant effects on body weight or condition scores. Of the testicular parameters analyzed, scrotal width, testis composition, and gross testicular parameters were unaffected, although a significant decrease (P<0.05) was found in the mean number of spermatids. No differences

were observed between treatment groups for either estrogen or testosterone concentrations. However, there was a significant time by treatment interaction for estrogen levels (P<0.05). No significant differences were seen for any of the sexual/aggressive behavioral parameters analyzed based on frequency, latency, or duration, at any point of the study. Nevertheless, several areas assessed in this study showed large variations between individual stallions. Further research of altrenogest in the stallions is needed to determine a practical dosage amount and sequence to produce a manageable animal, which takes age and fertility effects in consideration.

Key Words: Stallion, Altrenogest, Behavior

72 Social structure and behavior of laying hens in large groups. R. Freire^{*}, F. Short, and C.J. Nicol, *Bristol University, Bristol, United Kingdom.*

There has been a recent trend in Europe towards large group systems for the commercial housing of laying hens. The aim of this study was to obtain information about the spatial interaction and social cohesion of birds in large groups. A group of 1000 birds was housed in a perchery pen providing littered areas, individual nest boxes and a central frame of perches. Eighty birds were tagged with transponders that emitted a unique identification number each time they walked near antennae placed at 16 locations at each of 4 heights. Over a four-month recording period, approximately 85% of the tagged birds restricted their movement to particular areas (i.e. within a home range, chi-squared P<0.001). We tested the possibility that birds that occupy the area under the perches (i.e. the slats) for long periods of time are in poor health and retreat to this location as a means of avoiding social encounters. Increased use of the slats was significantly related to reduced weight (third order polynomial fitted line, F_{1,67}=6.6, P<0.0001) and poorer back feather condition (ANOVA, F_{1,67}=4.2, P<0.05). However, latency to move away from a group of birds and distance reached was not significantly correlated to time spent on the slats (multiple regression, P>0.1). In conclusion, the health and condition of a few individuals that become restricted to unfavorable areas may be compromised in large group systems.

Key Words: Social, Behavior, Hens

73 Survey of auction and slaughter horses. K. McGee¹, J. L. Lanier¹, and T. Grandin^{*1}, ¹Colorado State University.

Surveys of 10 non-cataloged auctions (n=1,473) and at 3 slaughter plants (n=1,348) were used to characterize the types of horses typically found. Informal interviews with industry people were conducted to gain an insight into why certain types of horses are more prevalent in auctions than in slaughter plants. Soundness of horses was based on guidelines in the U.S. Pony Club Guide to Conformation, Movement and Soundness, and foot condition and body condition was scored with a four-point and five-point scale, respectively. Interviews indicated that horses are typically not sold to a slaughter plant if there is potential for that horse to continue as a riding or working horse. Usable horses have a greater economic value at an auction than at a slaughter plant. The frequency for types of horses seen at slaughter and auction plants, respectively was riding horses 63% and 68%, mules, donkeys, ponies and miniatures 2% and 18%, racehorses 4% and 1%, feedlot horses fed for slaughter 9% and 0%, draft horses 7% and 2%, male horses (stallions, gelding, and colts) 50% and 57%, sound riding or working horses 13% and 47%, gray horses (70-90% have melanosis tumors) 10% and 10%, and horses with an official Bureau of Land Management freeze brand were 2% of the slaughter horses and less than 1% of all auction horses. Body condition for slaughter and auction horses, respectively was emaciated 3% and 2%, thin 27% and 20%, good 59% and 67%, and fat or obese 11% and 11%. Slaughter plant horses had substantially poorer foot condition than the auction horses. Neglected hooves that had damage of the coronary band were 10% of the slaughter horses versus 2% of the auction horses. Moderately neglected hooves accounted for 54% and 26%, acceptable hooves for 31% and 54% of slaughter and auction horses, respectively. More horses sold at auctions were sound usable riding/working horses than those sold to the slaughter plants. Slaughter plants in the United States assist in maintaining a level of horse welfare by preventing old and (or) unsound working/riding horses from being neglected.

Key Words: Equine, Welfare, Slaughter

74 Myofibrils isolated from red and white porcine muscles respond differently to pH. B. C. Bowker^{*1}, D. R. Swartz², A. L. Grant¹, and D. E. Gerrard¹, ¹Purdue University, West Lafayette, IN, ²Indiana University Medical School, Indianapolis, IN.

The pH-dependent ATPase activity of myofibrils from muscles varying in fiber type is thought to modulate postmortem muscle metabolism. The objective of this study was to determine the effects various conditions, simulating postmortem conditions, have on myofibrillar ATPase activity of red semitendinosus (RST) and white semitendinosus (WST) porcine muscle. The ATPase activity of myofibrils was measured at 39°C, 10-4 M Ca²⁺, and pH ranging from 5.0 to 7.5 at 0.25 unit intervals. To test if decreased pH irreversibly alters myofibrillar ATPase activity, activity was measured using myofibrils incubated 90 min at 39°C at pH 7.0, then pH 5.0 or 6.0, and back to pH 7.0. Maximum activity was at approximately pH 7.0 with WST myofibrils exhibiting greater ($P < .0001$) ATPase activity than RST myofibrils (0.621 vs. 0.445 nmole Pi/mg protein/min). Activity of both RST and WST myofibrils declined from maximum rates to approximately zero between pH 6.25 and 5.5. Activity declined to half-maximal levels at pH 5.95 in both RST and WST myofibrils. After incubation at pH 5.0, activity was not recovered in RST or WST myofibrils. Following incubation at pH 6.0, ATPase activity recovered to a higher ($P < 0.05$) percent of maximum activity in RST than WST myofibrils. These data suggest that postmortem muscle pH and muscle fiber type affect overall myofibrillar ATPase activity and that low pH may irreversibly alter myofibrillar proteins causing a loss in ATPase activity, with this pH sensitivity being more pronounced in WST than RST.

Key Words: Myofibrils, ATPase activity, pH

75 Relationship between muscle fiber type and pork quality traits of pigs selected for leanness and growth efficiency. C.R. Kerth^{*}, A.A. Helm, D.L. Kuhlert, L.B. Cagle, L.K. Blair-Kerth, and W.R. Jones, Auburn University, Auburn AL.

Progeny from the sixth generation of Duroc pigs selected for leanness and growth efficiency or a control line of pigs maintained from the base population were tested to determine the relationship between muscle fiber types and muscle quality traits. Random samples of pigs from each genetic line with mixed sexes ($n = 31$) were slaughtered at 114 kg. Longissimus muscles were measured for postmortem pH at 0.5, 1, 2, 3, 4, and 22 to 24 h postmortem. Chops were removed to determine Hunter L*, a*, and b* values, drip loss, water holding capacity, and fiber typing. Muscle fiber type samples were stained for acid-stable ATPase activity to determine muscle fiber type. Correlation and regression analyses were conducted to determine the relationship between muscle fiber type and muscle quality traits. No significant correlation existed ($P > 0.05$) between muscle fiber type and percent drip loss, Hunter a* and b* values, percent moisture, or postmortem pH at 0.5, 1, 2, 3, 4, and 22 to 24 hours. Genotype did not affect ($P > 0.05$) mean fiber type percentage. Hunter L* values were negatively correlated with slow-twitch oxidative (SO) fiber types ($r = -0.39$) and positively correlated with fast-twitch glycolytic (FG) fiber types ($r = 0.49$, $P < 0.05$). No correlation existed ($P > 0.05$) between percent free water and SO or FG fiber types. However fast-twitch oxidative, glycolytic (FOG) fiber types were negatively correlated ($r = -0.40$) with percent free water and positively correlated with percent bound and immobilized water ($r = 0.40$ and 0.40 respectively, $P < 0.05$). Regression analysis showed that percent FG muscle fiber types accounted for 23.8% and SO muscle fiber types accounted for 14.9% of the variation in Hunter L* ($P < 0.05$). The percentage of FOG fiber types accounted for 16.1% ($P < 0.05$) of the variation in percent free water. These data indicate that a relationship exists between muscle fiber type and objective muscle quality traits of pigs selected for increased leanness and growth efficiency.

Key Words: Muscle Fiber Type, Water-holding, Muscle Color

76 Variation in color and pH measurements throughout boneless pork loins. C. L. Lorenzen^{*1}, J. L. Norman¹, G. K. Rentfrow², C. A. Stahl², E. P. Berg², and M. R. Ellersieck³, ¹Food Science and Engineering Unit, ²Animal Sciences Unit, ³Department of Statistics, University of Missouri - Columbia.

Color is an extremely important consideration for merchandising pork both domestically and internationally. The objective of this study was to characterize the changes in color and pH throughout the length of the boneless pork loin. Center cut boneless pork loins ($n = 93$) were obtained commercially and segmented according to NPPC color standards assessed at the sirloin face of bone-in loins. Treatment 1 included NPPC color standards 1 and 2; treatment 2, standards 3 and 4; and treatment 3, standards 5 and 6. Loins were cut into 2.54 cm chops and allowed to bloom for at least 10 min. Hunter color L*, a*, b* values and pH measurements were taken on all chops in the loin starting at the sirloin end. Treatment affected ($P < .05$) all measures of color. Hunter color L*, a*, and b* values for chops differed ($P < .05$) by position of chop in the loin. All regression equations used to predict color values were polynomial with R² values of 0.71, 0.87, and 0.95 for L*, a* and b*, respectively. A treatment by position interaction ($P < .05$) existed for pH values with treatment 3, sirloin end being the highest and treatment 1, blade end the lowest. The center of the loin is typically merchandized as the high-value, high yield portion of the loin most popular with consumers. This study indicates that there is variation in color and pH throughout the loin; therefore, a single measurement at the end of the loin may not accurately predict the color of pork in the portion of the loin that creates retail demand.

Treatment	L*	a*	b*
1	58.17 ^a	6.35 ^b	15.18 ^a
2	51.48 ^b	6.99 ^{ab}	14.27 ^b
3	45.55 ^c	7.36 ^a	12.77 ^c

^{a,b,c}Means within a column lacking a common superscript differ ($P < .05$)

Key Words: Pork, Color, pH

77 In-home consumer acceptance of boneless pork loins varying in color. J. L. Norman^{*1}, C. L. Lorenzen¹, C. A. Stahl², G. K. Rentfrow², E. P. Berg², and H. Heymann¹, ¹Food Science and Engineering Unit, ²Animal Sciences Unit, University of Missouri - Columbia.

The objectives of this study were to determine the effects of color and light reflectance on Warner-Bratzler shear force values and (or) on consumer preferences for pork. Center-cut boneless pork loins ($n = 60$) were divided into three groups based on NPPC color standards. Treatment 1 included NPPC color standards 1 and 2; treatment 2, 3 and 4; and treatment 3, 5 and 6. Loins were cut into 2.54 cm chops. Two chops obtained from the center section of each loin were used to determine Warner-Bratzler shear force, Hunter color L*, a*, b*, and pH values. The "in-home" portion of this study consisted of two three-week repetitions where consumers prepared, consumed, and evaluated specific pork chops. Chops were allotted randomly for both treatment and week of repetition. Consumers used a nine-point sensory hedonic scale for the attributes overall likeness, tenderness liking, juiciness liking, and flavor liking; where 1 = dislike extremely and 9 = like extremely. A total of 47 households completed both repetitions of the study. Hunter color L*, a*, b*, and pH measurements differed ($P < .05$) by treatment. L* means were 57.01, 50.24, and 45.54 for treatments 1, 2, and 3, respectively. Warner-Bratzler shear force values were not affected by treatment ($P > .05$), but the percentage cook yield of dark pork was 3.5 % higher than light pork ($P < .05$). Consumers detected differences in juiciness and tenderness liking ($P < .05$) due to treatment. Warner-Bratzler shear force values were negatively correlated with a* and b* values ($P < .0001$; $r = -0.295$ and -0.314 , respectively). Neither, Warner-Bratzler shear force values nor consumer preferences were affected ($P > .05$) by color grouping or light reflectance.

Key Words: Pork Quality, Tenderness, Light Reflectance

78 Muscle glycogen and lactate content and pork quality traits as affected by available dietary carbohydrate in pigs. G. Bee*, ¹Swiss Federal Research Station for Animal Production.

The aim of the study was to determine whether muscle glycogen content and pork quality traits could be modified by availability of carbohydrates in the diet. Biopsy samples of longissimus (LM) from 48 Swiss Large White pigs (25 gilts; 23 barrows) weighing 70 kg were collected, and the glycolytic potential (GP = 2[(glycogen + glucose + glucose-6-phosphate) + lactate] was determined to vary from 111 to 187 $\mu\text{mol/g}$ wet weight. At 90 kg pigs were moved into individual pens and assigned (blocked by GP and sex) to be fed 2.8 kg of a diet either high (H) or low (L) in available carbohydrate up to 104 kg. Pigs were fasted over night (15 h) before slaughter. Glycogen and lactate content were determined in samples of LM (predominately glycolytic) collected 30 min and 24 h after stunning, and in samples of the dark part of the semitendinosus (ST, oxidative muscle) collected 24 h after stunning. Measurements of pH were carried out in the LM 30 min and 24 h after slaughter. Hunter L*, a*, b* values and drip losses were assessed the day after dissection. Overall glycogen and lactate levels 24 h postmortem were higher in the LM compared to the ST (19.5 vs. 11.5 $\mu\text{mol/g}$; 95.4 vs. 74.8 $\mu\text{mol/g}$; $P < 0.05$). Diets did not affect pH, color, drip losses, or glycogen and lactate concentrations of the LM. The diets affected the glycogen content of the ST in gilts (H: 14.7 vs. L: 9.2 $\mu\text{mol/g}$) but not in barrows. Lactate concentrations in the ST were also higher in pigs fed the H diet (H: 76.3 vs. L: 73.4 $\mu\text{mol/g}$; $P = 0.03$). Compared to diet L, Hunter L* values tended to be lower (H: 42.6 vs. L: 43.6; $P = 0.07$) in the ST of animals fed diet H, and b* (H: 6.8 vs. L: 5.6; $P < 0.05$) and drip losses (H: 4.8 vs. L: 3.1%; $P \leq 0.05$) were higher in gilts but were unaffected in barrows. Hunter L*, a*, b* and drip losses were positively correlated with glycogen (0.36; 0.34; 0.57; 0.59; $P < 0.05$) and lactate content (0.36; 0.28; 0.34; 0.27) in the ST, whereas the correlations were not significant in the LM. In conclusion, dietary treatment affected quality traits of the ST, but not of the LM muscle, and the effects were more pronounced in gilts than barrows.

Key Words: pigs, glycolytic potential, pork quality

79 Influences of nutritional levels on porcine muscle development and meat quality. Daiwen Chen*, Keying Zhang¹, Zhuyu Hu¹, Feiyun Yang², and Zuohua Liu², ¹Institute of Animal Nutrition, Sichuan Agricultural University, PR.China, ²Academy of Swine Research of Chongqing, PR.China.

This study was to investigate the growth models of pigmeat traits at high (HL) and low (LL) nutritional levels. Landrace x Rongchang barrows (n = 90) with 18 kg bodyweight (BW) were randomly allotted into two treatments with 3 replicates each. Pigs were fed with diets containing DE 14.2 MJ/kg and CP 18%, 15.5% and 13.2% for the stage of 18-50, 50-80 and 80-100 kg, respectively (HL) or diets with DE 12.1 MJ/kg and CP 15.5%, 13.2% and 11.2% for each stage (LL). For each replicate, 3 pigs were killed at 20, 35, 50, 80 or 100 kg BW to examine meat measurements. Quality traits were measured at 45 min postmortem. The amount (kg) of lean deposition increased linearly with BW ($= 0.4156 + 0.3299 \text{ BW}(\text{kg})$, $R^2 = 0.9997$, $P < 0.001$), but didn't vary with nutritional levels ($P > 0.05$). There were no differences for color score of longissimus muscle (LM) among treatments. LM area, lean percentage (LP) in carcass, intramuscular fat (IMF) content and water loss (WL) of meat after 5-min pressure under 35-kg force responded quadratically to BW (x, kg) ($P < 0.001$) as follows. Analyses of these equations showed that the effects of HL and LL on LM area and LP differentiated from 70 kg on, and those on IMF and WL from 40 kg. It was concluded that nutritional levels did not influence development models of meat traits and meat quality until pigs reach a certain bodyweight.

Key Words: Meat Quality, Development Model, Nutritional Level

80 Effects of dietary supplementation of copper and Vitamin E on pigmeat quality. Daiwen Chen*, Keying Zhang, Yongyi Li, Fangqun Li, Zhuyu Hu, and Xuwei Li, Institute of Animal Nutrition, Sichuan Agricultural University, Yaan, Sichuan 625014, PR.China.

Copper (Cu) is widely used as growth promoter for growing-finishing pigs in China. Whether Cu application has impacts on meat quality and vitamin E (VE) needs to be supplemented in Cu-containing diets are not

known. Two experiments were conducted in this study to investigate the effects of Cu or/and VE supplementation in diets on pigmeat quality. In Exp.1, 250 ppm Cu in form of copper sulfate or 200ppm VE or Cu and VE together were added into corn-soybean-meal basal diet(control) which contained DE 13.8MJ/kg, CP 16.5-14%, Cu 16-20 ppm, and VE 27-40 ppm. In Exp.2, 200 ppm VE was supplemented into 250-ppm-Cu basal diets(control) when pigs reached 20, 60 or 80 kg liveweight (LW). For each Exp., 36 Large White x Landrace barrows with initial LW of 20 kg were randomly allotted into 4 treatments with 3 replicates each. Pigs were slaughtered at 100kg LW. Cu supplementation tended to increase ($p < 0.1$) average daily gain (ADG), feed conversion rate (FCR), area of longissimus muscle, and decrease backfat thickness. No significant differences were observed for color scoring, marbling, pH, drip loss and the contents of protein, lipid, collagen, Cu, Fe and VE for both fresh meat and meat chops stored at -4°C up to 9 days. VE supplementation in diets either with or without Cu supplementation tended to improve ($p < 0.1$) ADG, FCR, color scoring, and decrease drip loss of fresh meat. Fe, Cu and VE contents in fresh meat were enhanced ($P < 0.05$). After meat chops were stored at -4°C for 9 days, VE content and color scoring were higher, and drip loss and lipid oxidation, reflected by thiobarbituric acid reaction value, were lower for VE supplementation ($p < 0.01$) compared to the control. The extent of effects was greater when VE was included at 20 kg LW than at 60 kg or 80 kg. There were no interactions between Cu and VE. It is concluded that Cu supplementation in growing-finishing diets has no adverse effects on pork quality and VE supplementation was able to improve pork quality and extend pork shelf life.

Key Words: Meat Quality, Copper/Vitamin E, Pigs

81 Effects of dietary levels of ideal protein on pig meat quality. Keying Zhang*, Daiwen Chen, Xianmei Luo, Xuwei Li, Fangqun Li, and Zhuyu Hu, Institute of Animal Nutrition, Sichuan Agricultural University, Yaan, Sichuan, PR. China.

There are no investigations on the relationship between dietary ideal protein (IP) levels and pork quality up to now. In this study, sixty Large White x Landrace barrows with initial live weight (LW) of 20 kg were used to examine the effects of dietary IP levels on meat quality. Five dietary IP levels were designed as 8, 11, 14, 17 and 20% on as-fed basis (DM 89%). Corn-soybean-meal diets were formulated to contain DE 14.2MJ/kg, digestible lysine 4.75 g per 100 g of N x 6.25, and a ratio of lysine: sulfur-containing amino acids: threonine and tryptophan on digestible basis of 100:61:64:20. Pigs were randomly assigned into each treatment with 4 replicates each and given ad libitum access until 100 kg LW, when 1 pig of each replicate was slaughtered to check carcass quality. The results were showed in the table. There were no significant differences among treatments in terms of meat pH, color scoring. However, as IP increased, area and drip loss of longissimus muscle significantly improved, while marbling and intramuscular fat decreased. Because marbling, intramuscular fat and drip loss are related to meat tenderness, juiciness and overall acceptability, this study indicates that appropriately low level of dietary ideal protein may be favorable to eating quality of pig meat.

Key Words: Meat Quality, Ideal Protein, Pigs

82 Validation of three cookery methods to eliminate Listeria monocytogenes on short versus long term aged country ham slices. J.S. Kotrola*, W.B. Mikel, and M. C. Newman, University of Kentucky, Lexington, KY.

Newly implemented USDA regulations dictate that all ready-to-eat products, of which Country-cured hams are classified, have validated cooking instruction on the label to be considered not ready to eat. Recent research indicates that if the USDA process for curing country hams is not strictly adhered to, then Listeria may possibly be present in sufficient numbers to cause illness in immuno-compromised individuals. Therefore, three cookery methods were evaluated on short versus long term aged country ham slices to determine mean temperature at which Listeria monocytogenes was no longer viable. Country-cured hams slices were inoculated with a cocktail of 5 strains of Listeria monocytogenes at 3.70×10^5 CFU/ml, 1.33×10^5 CFU/ml and 7.10×10^5 CFU/ml in preparation for cookery by microwave, oven and griddle respectively. Heating times were as follows: microwave (1000 watts) for 1, 2, 4, 6, 8 min.; oven (350°F) for 2, 4, 8, 12, 16, 20 min.; and Griddle (350°F) for 30, 45, 60, 90, 120, 150 sec. There were nine observations per cook

method and time combination. After the heat treatment, 25 gm of meat was rapidly mixed with 225 ml chilled UVM broth to terminate heating effect. Microwave heating effectively eliminated the *Listeria monocytogenes* cultures after 2 minutes for the long term ham and 1 minute for short term ham slices. Oven heating resulted in no viable cultures remaining after 8 minutes for the long term and short term cured products. Griddle heating eliminated populations after 45 sec for short term aged slices and after 60 sec for long term aged sliced. The efficacy of eliminating *Listeria monocytogenes* from country cured ham slices is dependent upon time, temperature, and cookery method used.

Key Words: *Listeria monocytogenes*, Country-cured ham, cookery

83 Analysis of postmortem tenderization in porcine *longissimus dorsi* muscle. C.P. Allison*, R.J. Tempelman, and M.E. Doumit, Michigan State University, East Lansing, MI.

Our objective was to quantify the rate and extent of postmortem tenderization in porcine *longissimus dorsi* (LD) muscle and determine if proteolysis of desmin corresponds to mechanical measures of tenderness. Berkshire (n=32) and Yorkshire (n=16) sired pigs were harvested on two days at a commercial abattoir. Four 5.72-cm sections of the LD were removed at d 1 from the 11th rib to the 3rd lumbar vertebrae. Loin sections were randomly assigned to aging treatments of 1, 3, 7 and 14 d, vacuum packaged and stored at 4°C. After storage, two 2.5-cm thick chops were cooked to an internal temperature of 71°C on Farberware Open Hearth™ broilers. Chops were cooled overnight at 4°C and three 1.27-cm diameter cores per chop were sheared with a Warner-Bratzler Shear (WBS) machine. No differences in WBS values were observed between breed or loin location (P>.05). Shear values decreased (P<.0001) from 4.1 kg at d 1 to 3.6 kg and 3.2 kg at d 3 and d 7, respectively. Chops aged for 7 and 14 d had similar WBS values (P>.05). Western blot analysis of desmin from 4 tender (<4 kg) and 4 less tender (>4.7 kg) samples at d 1 revealed that desmin degradation paralleled decreases in WBS. Intact desmin was typically undetectable in tender samples by d 7 and in less tender samples by d 14. Tenderization of most pork loin chops is complete by d 7, however some chops exhibit additional tenderization and desmin degradation between 7 and 14 d postmortem.

Key Words: Pork, Tenderness, Desmin

84 Desmin degradation influences water-holding capacity and tenderness of fresh pork. L.J. Rowe*¹, E. Huff-Lonergan¹, and S.M. Lonergan¹, Iowa State University Ames, Iowa.

Proteolysis of desmin and troponin-T has been related to increased tenderness of meat. Degradation of desmin may also influence water-holding capacity (WHC) by disrupting linkages among adjacent myofibrils as well as myofibrils and the sarcolemma which would allow more space for fluid to reside in the tissue. We hypothesized decreased proteolysis of the myofibril-associated protein desmin would result in reduced WHC and tenderness. The objective was to determine if degradation of desmin was related to WHC and/or tenderness of pork. Halothane negative Duroc pigs (n=82) were harvested and pH measurements of the *longissimus dorsi* (LD) were taken at 45 min and 24 h postmortem (PM). Drip loss was measured on LD chops taken at 24 h and held at 4°C for an additional 24 h. Warner-Bratzler shear (WBS) force measurements were made on chops held 5 d PM at 4°C. LD samples taken at 1 d PM and 5 d PM were analyzed by immunoblotting using antibodies for desmin and troponin-T. Immunoreactive bands were quantified using densitometry. Desmin degradation was indicated by a decrease in intensity of an approximately 55 kDa immunoreactive band while troponin-T degradation was indicated by an increase in a 30 kDa band. 24 h drip loss was significantly correlated with 45-min pH (-.372) and 24 h pH (-.329). Drip loss at 24 h was not correlated with 5 d troponin-T degradation (-.119, P=.28) but was correlated with desmin degradation (.437, P < .01) indicating that products with less desmin degradation may have greater drip loss. 45 min pH and 24 h pH measurements were also significantly correlated with 5 d desmin degradation (-.254, -.377 respectively) indicating higher pH products tended to have greater desmin degradation. WBS at 5 d was significantly correlated with 5 d desmin degradation (.295) and 5 d troponin-T degradation (-.295). These results indicated increased drip loss and decreased tenderness of pork may be related to reduced proteolysis of proteins like desmin. (This work was supported by the National Pork Producers Council.)

Key Words: Water-holding capacity, Tenderness, Desmin

85 Dietary Conjugated Linoleic Acid and IGF-I Transgene Effects on Pork Quality. J. S. Eastridge*¹, M. B. Solomon¹, V. G. Pursel¹, A. D. Mitchell¹, and A. Arguello², ¹USDA-ARS, BARC, ²Univ. de las Palmas de Gran Canaria, Spain.

Transgenic (T) pigs produced with a fusion gene composed of avian skeletal α -actin regulatory sequences and cDNA encoding human IGF-I have exhibited increased lean tissue and less fat than normal (N) controls. While the use of T-pigs for meat production has not yet been approved, it is worthwhile to explore the quality of the meat from these pigs. Thirty pigs (14 T and 16 N siblings) were finished on a control (CO) growing-finishing diet or with added conjugated linoleic acid (CLA) to 120 kg. Carcass weight for N pigs was heavier (P<.01) than for T (92.5 vs 87.4 kg, respectively); however T loin eye area (38.1 cm²) was 16% larger than in N (32.5 cm²). Backfat thickness was lower (P<.05) for T-CLA-fed pigs (21.4 mm) than for N-CO, N-CLA and T-CO pigs (29.8, 27.5 and 27.0 mm, respectively). Although pH at 45 min was higher (P<.01) in N (6.10) compared to T (6.01), there were no differences detected in ultimate pH (N=5.65 vs T=5.59). CLA affected pH at 45 min (5.99 vs 6.13 for CO and CLA, respectively) but not ultimate pH (CO=5.58; CLA=5.66). Gene and diet effects on pork quality traits of ultimate pH, amount of purge after 21 d, cook yield and shear force values were not different. Shear force for N vs T (6.3 vs 5.8 kg) and for CO vs CLA (6.1 vs 5.9 kg) was not different. Malonaldehyde (TBARS) formation after 5 d fresh, 21 d fresh and 6 mo frozen storage was not influenced by gene or diet. CLA added to growing-finishing diet may help reduce carcass fatness. Based on the present study, the muscle hypertrophy induced by the IGF-I transgene has no detrimental effects on quality of meat as compared to control.

Key Words: Pork quality, IGF-I transgenic pig, Conjugated linoleic acid

86 Enhanced rates of postmortem muscle glycolysis differ across porcine genotypes. M. D. Spire*¹, B. C. Bowker, J. E. Hammelman, A. P. Schinckel, A. L. Grant, and D. E. Gerrard, Purdue University, West Lafayette, IN.

Pork quality development varies with genotype. Mechanisms responsible for this variation likely involve postmortem muscle metabolism. Curiously, many genotypes do not develop adverse pork quality unless they are subjected to pre-slaughter stress or postmortem mishandling. The objective of this study was to challenge pork carcasses of different genotypes using electrical stimulation (ES) to determine if some genotypes are more susceptible than others to exaggerated postmortem muscle metabolism. Three different genotypes, fifty pigs each, were slaughtered, then subjected to ES (100V or 200V, 13 pulses, 2 sec on / 2 sec off) at 15 or 25 min post-exsanguination, or no stimulation (NS). *Longissimus* muscle (LM) pH and temperature were recorded at 1, 10, 20, 30, 40, 50, and 60 min, and 24 h postmortem. Samples were collected from LM at 1, 30, and 60 min, and 24 h and analyzed for glycogen, glucose, glucose-6-phosphate (G6P), and lactate concentration. Muscle pH, but not temperature, differed (P < .05) across genotype. Genotype altered (P < .05) muscle glucose, glycogen, G6P, and lactate concentrations postmortem. In particular, G6P decreased (P < .05) from 1 to 60 min postmortem for all genotypes; however, G6P at 24 h accumulated to concentrations equivalent to 1 min levels for one genotype, but only accumulated to concentrations equivalent to 30 min levels for the other genotypes. Genotype effects were not observed for color, firmness, drip loss, 24 h pH, or CIE L*, a*, b* values. These data show that genotypes respond differently to postmortem perturbation by altering muscle glycolysis.

Key Words: Genotype, Pigs, Muscle Metabolism

87 Effect of processing plant on pork quality. E. Hambrecht*¹ and M.W.A. Verstegen², ¹Nutreco, ²Wageningen University.

The objective of the present study was to compare meat quality of pigs processed at three different plants. Plant A and B worked with head-to-heart electrical stunning (Midas[®], Stork) while plant C had a CO₂-dip-lift system (87% CO₂, Butina). Line speed varied from 420 (plant B) to 500 pigs/hour (plant A and C). In plant A carcasses passed through a 3-phase rapid chilling tunnel (-15/-10/-1°C, air velocity (AV) 2-3m/s, 90 min), in plant B through a pre-cooling tunnel (4-5°C, AV 3-3.5m/s, 30

min), and in plant C carcasses were directly transported to the cold storage (1-3°C, AV 2m/s). All carcasses were chilled until 20 h postmortem when meat quality was measured in the loin (3rd/4th lumbar vertebra). From October to March, 9 batches of ~150 pigs each (halothane-negative, average carcass weight 87kg) were purchased at commercial farms, divided in three and sent to the plants on three consecutive days. Feed withdrawal, transport and lairage time were identical for the three plants within batch. At 30 min postmortem pH was measured: plant A and C showed a lower pH₃₀ than plant B (A: 6.50 and C: 6.53 vs. B: 6.70, P<.001). After 4 h, pH was highest at plant B and lowest at plant C (A: 6.06 vs. B: 6.12 vs. C: 5.99, P<.001). Ultimate pH (pH_u) was lowest for plant C (5.62), intermediate for plant B (5.68) and highest for plant A (5.71, P<.001). In agreement with other measurements, drip losses (DL) differed between plants (P=.057) with highest DL found at

plant C (C: 5.2% vs. A: 4.8%, P<.05, B: 5.0%, P>.10). The plants ranked the same with regards to conductivity as with DL (A: 5.5 vs. B: 6.5 vs. C: 7.4 mS, P<.001). Although instrumental color measurement (Minolta) did not show significant differences, visual scoring (Japanese color scale, 1-6, 6 being darkest) revealed a paler color for plant C (A and B: 2.9 vs. C: 2.7, P<.001). Correlations (corrected for plant, batch and day of slaughter) were low to moderate: DL showed highest correlation with conductivity (r=.63) but lower correlations with pH₃₀, pH_{4h} and pH_u (pH₃₀: r=-.38, pH_{4h}: r=-.38, pH_u: r=-.45). It is concluded that processing plant can affect meat quality with differences being most likely related to pre-slaughter stress, stunning and/or cooling systems.

Key Words: Pork quality, Stunning, Cooling

ASAS Nonruminant Nutrition: Health, Nutrition Interactions

88 Use of menhaden oil to alter n-6:n-3 fatty acid ratios in nursery pig diets. T. A. Meyer*, M. D. Lindemann, G. L. Cromwell, and H. J. Monegue, *University of Kentucky, Lexington, KY.*

Weanling pigs (n=125, 21.4 d of age, and 6.8 kg BW) were used in two 28-d experiments to evaluate five dietary n-6:n-3 fatty acid (FA) ratios on performance, cell-mediated immunity, and intestinal morphology. Pigs were blocked by weight and randomly allotted to five pigs/pen. Complex diets with 5% oil (menhaden, corn, or a mixture) and calculated n-6:n-3 FA ratios of 0.7, 1.9, 6.9, 35.5, and 70.0 were then randomly allotted to pens within a replicate. Diets were formulated to contain 1.28% lysine; all other nutrients met or exceeded requirement estimates (NRC, 1998). Pig weights and feed consumption were recorded weekly. Cell-mediated immunity was assessed on d 14 and 28 by measuring the inflammatory response to an intradermal injection of phytohemagglutinin solution in the ear. One pig/pen was euthanized on d 28 and sections of duodenum and jejunum were taken to measure villi height and crypt depth. No overall differences (P = 0.10) in ADG (402, 448, 433, 456, and 428 g/d), ADFI (608, 677, 694, 709, and 656 g/d), or F/G (1.52, 1.51, 1.61, 1.56, and 1.53) occurred with increasing n-6:n-3 ratios. The inflammatory response (1.02, 1.00, 0.99, 0.93, and 0.96; 0.90, 0.86, 0.83, 0.95, and 0.85 mm) did not differ (P = 0.10) with increasing n-6:n-3 ratios on d 14 or 28, respectively. Duodenum crypt depth did not differ with increasing n-6:n-3 ratios (220, 215, 231, 213, and 225 mm; P = 0.10), but a quadratic effect occurred in jejunum crypt depth (239, 244, 252, 259, and 233 mm; P < 0.05). The duodenum and jejunum villi height (394, 394, 411, 407, and 364; 408, 432, 431, 415, and 424 mm), and villi height:crypt depth ratios (1.92, 1.93, 1.89, 2.07, and 1.70; 1.78, 1.86, 1.77, 1.68, and 1.91) did not differ (P = 0.10) among dietary treatments. Alteration of dietary n-6:n-3 FA ratios did not influence performance or skin inflammatory response to PHA, but did have a small effect on intestinal morphology.

Key Words: Pigs, Fatty acids, Performance

89 Response of early-weaned pigs to pea protein isolate-based diets supplemented with chicken egg-yolk anti-E. coli (K88) antibody. A. Owusu-Asiedu*¹, R. R. Marquardt¹, C. M. Nyachoti¹, and S. K. Baidoo², ¹University of Manitoba, Winnipeg, Manitoba/Canada, ²University of Minnesota, Minneapolis, Minnesota/USA.

In practical swine production, enterotoxigenic *E. coli* (ETEC) infection and resulting scours is a major problem for young pigs especially where purified plant proteins compared to spray-dried porcine plasma (SDPP) are fed. The effect of supplementing a pea protein isolate (PPI)-based diet with egg-yolk antibodies (EYA) obtained from laying hens immunized with ETEC K88 on piglet performance and incidence of scours was studied in a 14-d experiment. Ninety 10-d old weaned pigs were assigned to 5 dietary treatments in a completely randomized design to 6 replicate pens per treatment. The treatments were PPI, PPI + EYA, SDPP, SDPP + EYA and PPI + SDPP. All diets were formulated to similar nutrient levels and provided for ad libitum consumption. On d 7, piglets were orally challenged with 6 ml of ETEC K88 dose of 10¹² CFU ml⁻¹. Piglets were weighed on d 7 and every other d after ETEC challenge. Weekly feed intake, BW change and number of piglets with scours and scour score were recorded. Fecal swabs from 10 pigs per treatment were taken for polymerase chain reaction (PCR) test to detect *E. coli* K88.

Feed efficiency ranged from 1.3 to 1.4 and was not affected (P>0.05) by dietary treatment. Mean daily feed intake was lower (P<0.05) in piglets fed diet PPI (64.3 g/d) compared to PPI + EYA (94.8 g/d) during WK 1. Piglets fed PPI without EYA had lower (P<0.05) ADG (84.0 g/d) compared to those fed PPI + EYA (123.0 g/d) or SDPP-based diets. Scour appeared in all groups of pigs 4-6h after ETEC K88 oral challenge. However, piglets fed PPI + EYA or SDPP-based diets recovered after 10h post-challenge, whereas those fed PPI continued to have severe diarrhea resulting in 46.5% mortality. PCR results showed that all PPI fed piglets continued to shed ETEC K88 at the end of the 14-d experimental period. It was concluded that specific EYA and SDPP can provide passive control of ETEC (K88) infection and potentially improve feed intake and weight gain in early-weaned pigs fed PPI

Key Words: Porcine plasma, *E. coli*, Scours

90 High levels of dietary ascorbic acid on liver gulonolactone oxidase activity, serum and liver ascorbic acid concentration, and growth performance of postweaning pigs. S. Ching*¹ and D.C. Mahan, ¹The Ohio State University.

Pig liver ascorbic acid synthesis activity was found to be suppressed while nursing the sow, but increased during the initial 2 wk postweaning. Blood and tissue ascorbic acid concentration declined postweaning and continued at a low concentration for several weeks. This experiment therefore evaluated the effects of feeding high dietary vitamin C levels on liver gulonolactone oxidase (GLO) activity, tissue ascorbic acid contents, and growth performance during a 38 d postweaning period. A randomized complete block design was conducted with four levels of dietary ascorbic acid (0, 500, 1000, 3000 ppm) in 12 replicates. Diets were comprised using typical Phase 1, 2, and 3 starter pig diets, except that a stabilized form of vitamin C (Stay C ? 35%) was used. A total of 260 crossbred pigs was weaned at 17 d of age and averaged 6.2 kg BW. At the end of each phase (10, 24, and 38-d postweaning) pigs were weighed and feed consumption measured. Pigs were bled at each period with the serum analyzed for ascorbic acid. Two pigs per treatment group were killed at the end of each period and liver GLO activity and ascorbic acid concentration determined. Daily gains (P < 0.05) and G/F ratio (P < 0.10) increased linearly as dietary ascorbic acid increased during the 0 to 10-d period, but not thereafter. Liver GLO enzyme activity decreased linearly (P < 0.01) at 10, 24, and 38 d as dietary vitamin C increased. As dietary vitamin C levels increased, serum ascorbic acid (P < 0.01), liver ascorbic acid (P < 0.01), and urinary ascorbic acid (P < 0.01) increased at 10, 24, and 38-d postweaning. These results indicate that high levels of dietary vitamin C suppressed vitamin C synthesis in the pig, but stimulated pig growth and feed efficiency during the initial 10-d postweaning with higher serum, tissue, and urinary ascorbic acid concentrations.

Key Words: Ascorbic acid, Gulonolactone oxidase, Weanling pigs

91 High levels of dietary ascorbic acid on liver gulonolactone oxidase activity, serum and liver ascorbic acid concentration, and growth performance of postweaning pigs. S. Ching* and D.C. Mahan, *Ohio State University.*

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Key Words: Ascorbic Acid, Weaning, Pigs

92 Effects of brewers dried yeast as a source of mannanoligosaccharides and of carbadox on total, *Escherichia coli* K88, and carbadox-resistant coliform populations in early-weaned pigs. L. A. White*, M. C. Newman, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington, KY.*

Effects of brewers dried yeast, as a source of mannanoligosaccharides (MOS), and carbadox on enteric microbial populations in young pigs were evaluated. In two trials, pigs ($n = 12$ /trial) were weaned at 11 d of age (4.1 kg BW) and placed in isolation chambers (two pigs/chamber) equipped with individual air filtering systems and excrement containers. Treatments were a non-medicated basal diet, a diet with 55 mg/kg of carbadox, and a diet with 3% yeast. Diets were fortified corn-soy-dried whey-lactose-animal plasma and contained 1.5% lysine (total). Diets were fed for 29 d, then each pig was bled and orally dosed with approximately 9.5×10^8 CFU of *E. coli* K88. Fecal swabs were collected daily from inoculation (d 0) to d 10. Total, K88, and carbadox-resistant coliforms were enumerated daily, and total serum protein levels were measured from blood sampled on d 0 and d 10. All pigs were killed on d 10 (18.5 kg BW) and bacterial samples were obtained from the intestinal wall of the small intestine, cecum, and colon. Agglutination tests confirmed adsorption of K88 and other serovars of *E. coli* and *Salmonella* spp. with yeast. A few differences among pigs fed the basal, carbadox, or yeast diets were detected in total coliform (2.9, 2.6, 2.6 log CFU/g tissue), *E. coli* K88 (1.6, 1.4, 1.6), and carbadox-resistant (1.7, 1.3, 1.6) populations in the small intestine, cecum (5.7, 4.6, 5.2 [$P < 0.05$]; 2.4, 2.6, 3.1; 2.8, 2.4, 2.5), and colon samples (5.8, 5.4, 5.4; 2.7, 3.2, 2.9 [$P < 0.05$]; 3.1, 3.4, 3.2). Daily fecal K88 counts were not different ($P > 0.05$) among treatments, but counts of carbadox-resistant coliforms were higher ($P < 0.05$) throughout the 10-d period in the carbadox vs basal or yeast treatments. Serum protein levels were higher ($P < 0.05$) for the yeast group on d 0 (2.4, 3.1, 3.4 g/dl serum) but not at termination (4.7, 5.0, 4.7). In this trial, brewers dried yeast and carbadox had minimal effects on microbiological and immunological traits in early-weaned pigs.

Key Words: Pigs, Coliforms, Yeast

93 The effect of feeding spray-dried porcine plasma and egg immunoglobulins with anti-bacterial or anti-somatostatin specificities on the performance of weaned pigs. M. D. Drew* and A. E. Estrada, *University of Saskatchewan, Saskatoon SK Canada.*

A total of 120 weanling pigs (18 d of age; 6.0 Kg mean weight) were used to evaluate the effect of feeding porcine plasma (PP) with two different egg immunoglobulin (Ig) products. The first egg Ig was produced by immunizing laying hens with a bacterin containing *E. coli* F4, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Enterococcus faecalis*, *Klebsiella pneumoniae* and *Clostridium perfringens*. The second egg

Ig was produced by immunizing hens against a somatostatin (SRIF)-bovine serum albumin conjugate. The eggs were spray-dried before use. Thirty pigs (5 per pen) were randomly assigned to one of four diets: 1) Control-containing no plasma or egg, 2) Plasma-control diet with 2.5% PP added, 3) Bacterial Egg-control diet with 1.0% PP; 0.5% anti-bacterial egg added and 4) SRIF Egg-control diet with 1.0% PP; 0.5% anti-SRIF egg added. The diets were not pelleted and provided equal crude protein, lysine, methionine, threonine and digestible energy. Pigs were fed ad libitum and pig weights and feed intakes were measured on days 0, 7 and 14. During the first 7 days, pigs receiving the SRIF egg diets had significantly higher average daily gains (ADG) ($P < 0.05$) compared to the controls (143 g/d vs 83 g/d). Plasma or Bacterial Egg fed pigs had ADG (121 g/d and 128 g/d respectively) which were not significantly different from the Controls or SRIF egg groups. The Plasma fed pigs had higher ($P < 0.05$) average daily feed intakes (ADFI) than the other three groups during the first week of the experiment. Feed:gain ratios (F:G) were reduced ($P < 0.05$) in the pigs fed the Bacterial or SRIF egg diets (1.19 and 1.09 respectively) compared to the controls and Plasma diet fed pigs (1.79 and 1.50 respectively). No significant differences were seen during the second week of the experiment. The results suggest that anti-bacterial or anti-SRIF egg Igs combined with low levels of plasma can increase the growth and feed efficiency of weaned pigs.

Key Words: Pig, Immunoglobulin, Somatostatin

94 Pre- and postweaning performance of piglets fed pre-weaning diets containing either spray-dried porcine plasma, whey protein concentrate or whey powder. A.J. Van Dijk*¹, M. Ubbink-Blanksma¹, J.G.P. Van der Palen¹, and A.C. Beynen², ¹Co-operative Central Laboratory Nutritional Control, P.O. Box 107, 5460 AC Veghel, The Netherlands, ²Dept. Nutrition, Utrecht University, Veterinary Faculty, P.O. Box 80152, Utrecht, The Netherlands.

We studied the effect of the addition of either delactosed whey powder (WP), spray dried porcine plasma (SDPP) or whey protein concentrate (WPC) to creep feed on pre- and post-weaning performance and health of piglets. Inclusion levels in the diets were 17.7, 5.0 and 13.1 %, respectively. SDPP or WPC were exchanged for WP in the control diet on an isonitrogenous basis. During the period from thirteen days before weaning until weaning, the piglets (17 litters per treatment) were offered one of the three experimental creep feeds followed by a weaner diet after weaning, that was identical for all three treatment groups. During the pre-weaning period there were no significant differences in feed intake and daily gain between the treatment groups (Table 1). During the first week after weaning, the piglets that had been fed the SDPP diet before weaning, had a significantly higher average daily feed intake (ADFI) than did the piglets that were fed the WPC diet before weaning. During the fourth week after weaning, the piglets given the creep feed with SDPP diet before weaning had a significantly higher average daily gain (ADG) and lower feed conversion ratio (FCR) than the piglets that were fed the creep feed with WP. For the entire post-weaning period there were no major differential effects on ADG, ADFI and FCR as mediated by either SDPP, WPC or WP in the creep feed. It is concluded that the type of protein in creep feed can have carry-over effects on post-weaning growth performance.

Diet	WP	SDPP	WPC	SEM
ADG (g/day)				
14 days before weaning until weaning	295	310	314	9
After weaning, days:				
1-7	162	170	167	16
8-14	290	333	321	21
15-21	428	464	454	24
22-28	550 ^a	621 ^b	586 ^{ab}	24
ADFI (g/day)				
14 days before weaning until weaning	12	15	13	2
After weaning, days:				
1-7	171 ^{ab}	192 ^a	156 ^b	11
8-14	361	399	383	21
15-21	616	692	633	36
22-28	837	909	912	33

^{a,b}Means within the same row without a common superscript letter differ significantly ($P < 0.05$).

Key Words: Piglet, Creep-feed, Protein

95 Evaluation of Termin-8[®] addition to spray-dried animal plasma or base mix on growth performance of nursery pigs. J.M. DeRouche¹, R.E. Musser², W.N. Cannon³, M.D. Tokach¹, J.N. Nelssen¹, R.D. Goodband¹, and S.S. Dritz¹, ¹Kansas State University, Manhattan, ²The Pork Group, Rogers, AR, ³NutraBlend, Neosho, MO.

A total of 1698 pigs (BW of 5.0 kg and 17 d of age) were used in a 13 d growth assay to determine the effects of Termin-8[®] (Anitox Corp.) addition to the spray-dried animal plasma (SDAP) or base mix portion of a SEW diet on growth performance in nursery pigs. Termin-8[®], an antibacterial feed additive, contains a mixture of aliphatic acids, formaldehyde, and natural terpenes. Pigs were housed in a commercial research nursery with 12 to 19 pigs per pen (uniform within each block) and 36 pens per treatment. Pigs were allotted to one of three SEW dietary treatments. The treatment diets included: 1) control diet (1.67% lysine, 7% SDAP); 2) control diet with Termin-8[®] application (3 g/kg) to the SDAP portion of the diet; and 3) control diet with Termin-8[®] application (3 g/kg) to the base mix portion (specialty protein products, milk products, oat groats, vitamins, minerals, and antibiotic) of the diet. All pigs were fed 2.27 kg of their respective treatment diet and then a common transition diet (1.47% lysine) for the remainder of the treatment period. For d 0 to 8, pigs fed diets containing Termin-8[®] in the SDAP or base mix portions had increased ($P < .01$) ADG and gain/feed compared to the pigs fed the control diet. Also, pigs fed SDAP with Termin-8[®] treatment had greater ADG ($P < .01$) and tended to have improved gain/feed ($P < .07$) compared to pigs fed Termin-8[®] treated base mix. Overall (d 0 to 13), ADG ($P < .01$) and gain/feed were greater ($P < .05$) for pigs fed diets containing Termin-8[®] treatment to the SDAP or base mix portion compared to pigs fed the control diet. In conclusion, adding Termin-8[®] to the SDAP or base mix at 3 g/kg before diet manufacturing improved pig performance.

Item	Termin-8 [®] Application			SEM
	Control	Plasma	Base Mix	
d 0 to 8				
ADG, g	171	222	205	5.7
ADFI, g	176	183	184	5.2
G/F, g/kg	1005	1232	1125	38
d 0 to 13				
ADG, g	219	251	246	6.6
ADFI, g	259	265	265	7.9
G/F, g/kg	846	947	928	31

Key Words: Pig, Growth, Termin-8[®]

96 Dietary supplementation of different organic acids as an alternative to the use of antibiotics in the diets of early-weaned piglets. M. Borysenko^{*}, M.Z. Fan, T. Archbold, J.L. Atkinson, C. Dewey, and H. Engelhardt, *University of Guelph, Guelph, Ontario, Canada.*

The objective of this study was to evaluate the use of organic acids as alternatives to antibiotics in the diets of early-weaned piglets. Average daily gain, feed efficiency, organ weight gain, diarrhea scores, white blood cell counts and blood urea nitrogen (BUN) were the endpoints measured. A total of 216 Yorkshire piglets, weaned at the age of 14 d with an average BW of 4.71 kg, were used in the study. A randomized complete block design was used. Pigs were blocked by replication time, equalized for gender, allotted to one of six treatments using six pigs per pen and six replicate pens per treatment. Animals were housed in a nursery in raised pens with rubberized woven wire floors with free access to feed and water. Six diets were used: control diet (CD, antibiotic Lincomix 44 at 1 kg/tonne of feed), negative control (NC, no antibiotic) and lactic (LAD), formic (FAD) and fumaric acid (FUM) diets containing 0.65% organic acid. A low cost diet (LCD) contained 0.2% of each acid. Piglets were fed the diets from d 1 to 20 post-weaning. All endpoint measurements were taken at d 10 and 20. One representative male and female piglet from each treatment group were sacrificed and

samples (blood, stomach, liver, spleen, proximal and distal small intestine) taken. The CD group had a higher ($P < 0.05$) growth rate at d 20 post-weaning than the NC, LAD, FAD, FUM and LCD groups (146.7 vs. 133.5, 136.6, 133.1, 133.2 and 117.1, SEM = 2.4g/d). BUN at d 20 was lower ($P < 0.01$) in the CD group than in the other treatment groups (4.33 vs. 5.39, 5.85, 5.67, 6.60 and 7.27, SEM = 0.44 mmol/L). There were no differences ($P > 0.05$) between treatment groups for the remaining measurements. In conclusion, organic acid supplementation does not improve growth performance of early-weaned piglets under our experimental conditions. BUN is a more sensitive indicator of growth and protein metabolism than the other parameters examined.

Key Words: Organic acids, Early-weaned piglets, Antibiotics

97 Effects of ractopamine on pigs fed diets with and without vitamin and trace mineral premixes in late finishing (90 kg to slaughter). C. W. Starkey^{*}, J. D. Hancock, G. A. Kennedy, C. L. Jones, D. J. Lee, C. M. Dodd, and J. D. Dunn, *Kansas State University, Manhattan.*

A total of 192 pigs (avg initial BW of 90 kg) were used to determine the effects of ractopamine (RAC) on finishing pigs fed diets with and without vitamin and trace mineral premixes (VTM). The pigs were blocked by sex and weight and allotted to 16 pens with 12 pigs per pen. Treatments were arranged as a 2 x 2 factorial with main effects of VTM status (with vs without) and RAC treatment (none vs 19.8 g/ton of feed). The treatments were administered for the last 25 d before slaughter. Diets were corn (ground to 600 microns)-soybean meal-based with 1% lysine, 0.65% Ca, 0.55% P, and 2% added fat. The diets were fed in meal form and consumed on an ad libitum basis. Deletion of VTM did not affect growth performance ($P > 0.2$) or last rib backfat thickness ($P > 0.9$), but addition of RAC increased ADG ($P < 0.03$), tended to increase gain/feed ($P < 0.06$), and decreased last rib backfat thickness ($P < 0.01$). There was a tendency, however, for the beneficial effects of RAC on backfat thickness to be expressed only when the VTM were in the diets (VTM x RAC interaction, $P < 0.06$). The number of broken vertebrae was decreased when RAC was added to diets with VTM but was largely unaffected when RAC was added to diets without VTM (VTM x RAC interaction, $P < 0.02$). Deletion of VTM and additions of RAC did not affect scores for stomach ulcers ($P > 0.33$). In conclusion, there was no evidence to suggest negative effects in either growth performance or carcass measurements when RAC was added to diets without VTM.

Item	With VTM				SE
	Without RAC	With RAC	Without RAC	With RAC	
ADG, kg	1.04	1.08	1.00	1.09	0.03
ADFI, kg	2.70	2.67	2.71	2.75	0.04
Gain/feed	0.386	0.406	0.367	0.395	0.012
Backfat thickness,mm	26	24	25	25	1
Broken vertebrae	0.47	0.08	0.21	0.26	0.11
Stomach ulcers	0.06	0.00	0.05	0.08	0.05

Key Words: Pigs, Vitamin and mineral premix, Ractopamine

98 Effects of ractopamine on pigs fed diets with and without vitamin and trace mineral premixes in the finishing phase (70 kg to slaughter). C. W. Starkey, J. D. Hancock^{*}, G. A. Kennedy, C. L. Jones, D. J. Lee, C. M. Dodd, and J. D. Dunn, *Kansas State University, Manhattan.*

A total of 192 pigs (avg initial BW of 70 kg) were used to determine the effects of ractopamine (RAC) on finishing pigs fed diets with and without vitamin and trace mineral premixes (VTM). The pigs were blocked by sex and weight and allotted to 16 pens with 12 pigs per pen. Treatments were arranged as a 2 x 2 factorial with main effects of VTM status (with vs without) and RAC treatment (none vs 19.8 g/ton of feed). The treatments were administered for the last 50 d before slaughter. Diets were corn (ground 600 micron)-soybean meal-based with 1.2% lysine, 0.65% Ca, and 0.55% P, for 70 to 90 kg BW and 1% lysine, 0.65% Ca, and 0.55% P for 90 to 118 kg BW. The diets were fed in meal form and consumed on an ad libitum basis. No interactions were observed among the VTM and RAC treatments for ADG, ADFI, or gain/feed ($P > 0.2$). Deletion of VTM premixes from 70 kg to slaughter decreased overall ADG ($P < 0.01$) with no effects on ADFI ($P > 0.09$) or gain/feed ($P > 0.23$). Addition of RAC did not affect overall ADG ($P > 0.23$), but decreased ADFI ($P < 0.01$) and increased gain/feed ($P < 0.04$).

There were no interactions among the VTM and RAC treatments for last rib backfat thickness, broken vertebrae, or scores for stomach ulcers ($P > 0.21$). Also, deletions of VTM premixes did not affect these same measurements ($P > 0.22$). However, RAC decreased ($P < 0.01$) backfat thickness by 8% and tended to decrease scores for stomach ulcers ($P < 0.06$). In conclusion, there were no interactions to suggest that the effects of RAC on growth performance and carcass leanness were altered by deletion of VTM.

Item	With	VTM	Without	VTM	SE
	Without RAC	With RAC	Without RAC	With RAC	
ADG, kg	1.09	1.09	1.02	1.06	0.02
ADFI, kg	2.95	2.65	2.82	2.60	0.08
Gain/feed	0.371	0.413	0.361	0.408	0.008
Backfat thickness, mm	18	17	20	17	1
Broken vertebrae	0.27	0.28	0.09	0.35	0.10
Stomach ulcers	0.01	0.00	0.04	0.00	0.01

Key Words: Pigs, Vitamin and mineral premix, Ractopamine

ASAS/ADSA Breeding and Genetics: Breeding Strategies for Dairy Cattle

99 Evaluation of corrective mating programs for dairy cattle in the U.S. E.N. Sonnek*, L.B. Hansen, and A.J. Seykora, *University of Minnesota, St. Paul, MN.*

Corrective mating programs have been popular with dairy producers for many years, and recently they have been promoted as tools to avoid inbreeding. Six AI companies, two breed associations, and one commercial vendor answered a 42-question survey on the details of their corrective mating programs. The total number of cows mated annually in the US is about 2.7 million with individual programs ranging from about 90,000 to about 600,000. Corrective mating programs use phenotypes and PTAs for multiple traits (including production and type) to optimize mate selection. All of the programs mate heifers by PTAs from pedigrees, by phenotype on linear type traits, or a combination of the two. Most of the programs are run on a laptop on the farm or on a PC in the evaluator's office. Two programs are run strictly from the organization's headquarters. All programs are flexible regarding which traits of animals are used as well as methods for sire selection. When gathering pedigrees on females, six of the programs use only sire and maternal grandsire (MGS). Of these six, five programs use three-generation pedigrees of the selected mate, the female's sire, and MGS to check for common ancestors. Of these five, three check for common ancestors only among the males of these three-generation pedigrees. The sixth program (that gathers only the female's sire and MGS) utilizes complete pedigrees back to the 1960's. Two programs gather the maternal great-grandsire of the female in addition to the sire and MGS. One of these programs uses a three-generation pedigree including males and females while the other uses a five-generation male only pedigree when checking for common ancestors. Finally, only one program uses full pedigrees of selected mates and females back to the 1960's when calculating inbreeding coefficients. Obviously, great differences exist on the depth of pedigrees utilized to accurately prevent inbreeding depression. A significant portion of potential inbreeding is not detected if only a few generations are used, especially considering that the two bulls with highest relationship to the breed would appear several generations back in pedigrees.

Key Words: Corrective mating, Negative assortive mating, Inbreeding

100 Analysis of the relationship between linear type traits, inbreeding, and survival in US Jersey cows. Daniel Z. Caraviello*, Kent A. Weigel, and Daniel Gianola, *University of Wisconsin, Madison WI/USA.*

The ability of a dairy cow to resist involuntary culling is of high economic importance to the dairy farmer. Genetic improvement of survival can lead to lower replacement costs, decreased veterinary costs, more opportunities for voluntary culling, and a higher proportion of cows producing at a mature level. The objective of this study was to evaluate the relationship between linear type traits and survival in Jersey cattle. Because some traits may have an intermediate optimum or a threshold above which there is little impact on culling, we were interested in both linear and nonlinear relationships. Data for this study were obtained from USDA Animal Improvement Programs Laboratory, and these included 124,953 Jersey cows in 2258 herds with first calving between January 1, 1981 and December 31, 1993. Average age at termination was 1978 days. Our model included the effects of herd, year of calving, season of calving, age at first calving, and within-herd quartiles for mature equivalent milk, fat, and protein yield in the terminal lactation. Linear and quadratic regression coefficients corresponding to inbreeding coefficients and thirteen linear type traits were added to the

model one at a time. Linear regressions on strength, dairy form, foot angle, rear legs side view, rump angle, thurl width, fore udder, rear udder height, rear udder width, udder depth, suspensory ligament, and front teat placement were all positive and significantly different from zero. Quadratic effects of strength, foot angle, rear legs side view, rump angle, thurl width, fore udder, rear udder height, rear udder width, udder depth, suspensory ligament, and front teat placement were all significant and negative, indicating the likelihood of nonlinear relationships between type traits and survival. Inbreeding had a highly significant negative relationship with survival; a one percent increase in inbreeding resulted in a decrease in survival of approximately 40 days. Results of the linear model analysis will be verified using survival analysis methodology.

Key Words: Survival, Type Traits, Inbreeding

101 Effects of information in pedigrees on estimates of inbreeding depression for days to first service and summit milk yield. B. G. Cassell* and V. Adamec, *Virginia Polytechnic Institute and State University.*

Data from Holstein cows processed by DRMS Raleigh were used to estimate inbreeding depression in number of days to first service and summit milk yield. Pedigree information on all cows in this study was retrieved from AIPL, Beltsville, MD and combined with cow records. A procedure based on contribution of each ancestor in a five-generation pedigree to inbreeding coefficient was used to evaluate percentage of information present in cow pedigrees. Four groups of herds with about 50,000 cows each were randomly selected from the data. Group one included herds of grade cows where at least 85% of cows had 0-30% of available pedigree. Groups two (grade, 31-70%), three (grade, 71-100%) and four for herds with registered cows above 70% pedigree were formed similarly with 7% of herds contributing data to both group 3 and group 4. Inbreeding was calculated using standard methods and averaged 0.03%, 1.8%, 2.0%, and 3.7% for groups 1 to 4, respectively. Standard deviations were 0.7%, 2.0%, 2.2%, and 2.4% for the same groups. Mixed models for the two traits included herd-year-season (random), lactation number, inbreeding covariate, animal and permanent environmental effects associated with a cow. Three generations of pedigree were used in the numerator relationship matrix. Estimates of inbreeding depression from MTDFREML analysis of days to first service were -0.23 ($p=0.10$), 0.07 ($p=0.13$), 0.15 ($p=0.003$) and 0.03 ($p=0.27$) days for groups 1 to 4. Summit milk yield averaged between 36-38 kg in all groups, with estimated inbreeding depression of -0.12, -0.06, -0.06, and -0.07 kg. Effects of inbreeding were significantly different from zero ($p<0.001$) with significance increasing from group 1 to group 4. Estimates of inbreeding depression for days to first service were greater from grade herds with more pedigree data, a trend not confirmed in registered cows.

Key Words: Days to first service, Summit milk, Inbreeding depression, Pedigree

102 Minimization of rate of inbreeding for populations with overlapping generations combining live and frozen genetics. A.K. Sonesson* and T.H.E. Meuwissen, *Institute of Animal Science and Health, Lelystad, The Netherlands.*

We present a method that minimizes the rate of inbreeding (ΔF) for small unselected populations with overlapping generations. It minimizes the increase of coancestry of parents and optimizes the contribution of

each selection candidate. The carrying capacity of the population is limited to a fixed number of animals per year. For survival rates <100 % the algorithm has to optimize the use of few old and less related animals with many young and higher related animals. For a scheme where the oldest animals were selected, ΔF increased with 18-52 % compared with the proposed method. When freezing semen of all sires in a gene bank and assuming that each sire can be used infinitely, the relationships are set in the first 2-3 years, and thereafter the average coancestry of the population stays about the same, such that ΔF is approximately zero. Thus, the relationships among the live animals converges to that of the cryo-conserved sires. The level of inbreeding in the optimal schemes with 6 new-born animals per year (3 sires + 3 dams) is 0.060, which is lower than the expected level of inbreeding when simply the 3 founder sires were cryo-conserved, i.e. this would result in an inbreeding coefficient of 0.083 ($=1/(4*3)$). The latter implies that the optimal method also conserves genes of the founder dams by using frozen semen of their male offspring.

Key Words: Minimization of Rate of Inbreeding, Overlapping Generations, Genebank

103 Non-random mating schemes for selection with restricted rates of inbreeding. A.K. Sonesson* and T.H.E. Meuwissen, *Institute of Animal Science and Health, Lelystad, The Netherlands.*

Non-random mating has been shown to decrease rate of inbreeding (ΔF), but have no effect on genetic gain for BLUP and phenotypic selection. However, with optimum contribution selection, ΔF is restricted and the improved family structure due to non-random mating is instead used to increase selection differential, i.e. increase genetic response. For schemes with discrete generations, ΔF restricted to 1.0% and 100 selection candidates per generation, minimum coancestry mating with only one offspring per mating pair (MC1), increased genetic gain with 22% compared with random (RAND) mating. The increased genetic gain is mainly because MC1 mating results in more independent selection within and over generations. Compensatory mating on either the average relationship or the genetic contributions, which reduces the Q^2 effect of Robertson by connecting successful with unsuccessful families, resulted in just somewhat higher genetic gain than RAND mating. For schemes with a less stringent constraint on ΔF (2.5%) or more candidates (200), the genetic superiority of MC1 mating was reduced to 5-6%. Schemes with overlapping generations are mostly larger than schemes with discrete generations, because there are several reproductive age classes, which would decrease the effect of non-random mating for schemes with overlapping generations. There are however also more different family structures over the age classes, which would increase the effect of non-random mating. We compared the effect of non-random mating for discrete and overlapping generations at the same ΔF (0.25%) and genetic gain per generation. This comparison resulted in 17 and 3 % higher genetic gain for MC1 for schemes with overlapping and discrete generations, respectively.

Key Words: Selection, Inbreeding, Non-random Mating

104 Implementation of an approximate multitrait BLUP evaluation to combine production traits and functional traits into a total merit index. V. Ducrocq*, D. Boichard, A. Barbat, and H. Larroque, *Station de Génétique Quantitative et Appliquée, INRA, Jouy-en-Josas, France.*

The new total merit objective function for French dairy breeders combines information on production traits (50% of the total weight in Holstein) and functional traits (with weights of 12.5% for somatic cell count, female fertility, functional longevity and overall type). Traditionally, total merit indexes are constructed based on index selection theory, for bulls and cows separately, and often neglecting correlations between records from one same cow or differences in reliability between traits. In order to approximate an optimal evaluation procedure in a general, yet simple framework, a multiple trait BLUP evaluation applied to an animal model was implemented: pre-adjusted records for production traits, somatic cell scores, female fertility, length of productive life and some (4-6) type traits considered as good predictors of functional longevity and somatic cell scores were derived from each trait evaluation, eliminating the influence of environmental factors. It was checked that in the case of functional longevity, the newly defined pre-adjusted record and its associated weight led to univariate BLUP EBVs for bulls very close to those obtained with the survival analysis mixed model currently used.

Then for each trait, the pre-adjusted record for each cow could just be described as an overall mean plus an additive genetic effect. The combination of this simple model and of a canonical transformation of the data applicable to situations with missing records and variable weights made the multiple trait BLUP evaluation computationally feasible. The total merit index for males and females was obtained as a linear combination of the resulting EBVs, based on the true economic weights of the traits. An interesting by-product of this strategy was the production of improved EBVs for functional longevity combining direct information with information from early predictors.

Key Words: Total merit index, Dairy cattle, Multiple trait evaluation

105 Is Crossbreeding the Answer to Questions of Dairy Breed Utilization? A J McAllister*¹, ¹University of Kentucky.

The current interest in crossbreeding in the commercial dairy industry, even though it is quite limited, raises questions of breed utilization. Less than 5 percent of U.S. dairy cattle are other than purebred or grade Holsteins. The large advantage of Holsteins for additive genetic merit for lactation milk yield is apparently responsible. Why then is there this interest in crossbreeding? The economic importance of traits such as reproduction, health and survival in dairy production systems is likely the basis for the interest in crossbreeding, even though these traits are secondary to milk yield. Several U.S. studies and a Canadian study confirmed that while several crossbred groups were equivalent to Holsteins for lactation milk yield none was superior. Two crossbred groups in the Canadian study had equivalent lifetime yields, milk value and net returns to Holsteins. In the New Zealand study, Friesian-Jersey reciprocal crossbreds were predicted to exceed Friesians in first lactation fat yield. Crossbred performance is dictated by a combination of additive and non-additive genetic effects. Evidence exists for direct, maternal, heterosis and cytoplasmic maternal effects. Heterosis of 15-20% for lifetime traits was found in two studies. Results from previous crossbreeding studies have something to recommend for inclusion of Holstein, Ayrshire, Brown Swiss and Jersey breeds in a crossbreeding scheme. However, multiple generation lifeline performance on an array of purebreds and crossbreds under U.S. condition does not exist. Full unique identification of individual animals, including breed, permits the use of DHIA data to examine field data for the traits recorded therein. Survival data from birth and health data would need to be fully recorded to provide complete data on lifetime performance. Self-propagation of crossbred replacements is mandatory if any crossbreeding system is to be successful. At present a two breed rotational crossing systems appears to be the most viable system to maximize economic merit. Full-scale long term breeding experiments or analysis of field data paired with a comprehensive modeling of use of alternative breed utilization strategies for U.S. conditions are recommended.

Key Words: crossbreeding, breed utilization

106 Heterosis and breed differences for yield and somatic cell scores of US dairy cattle in the 1990s. P.M. VanRaden*, *Agricultural Research Service, USDA, Beltsville, MD.*

Yields and somatic cell scores (SCS) of 8806 F1 crossbreds and 81,409 purebreds were examined using test-day data from 320 US herds that each had ≥ 10 crossbred cows born since 1990. Comparisons were made within herd, year, and 3-mo calving season, although some groups contained only purebreds or only crossbreds. The model included effects of age and lactation stage, parent breeds, regression on sire predicted transmitting ability, and general heterosis. Estimates of heterosis for first parity were 4.6% for milk yield, 5.3% for fat yield, 4.9% for protein yield, and 0.6% (unfavorable) for SCS. Corresponding estimates for all parities were 4.7, 5.0, 4.9, and 0.3%. A model without an adjustment for sire merit produced slightly lower estimates. For Brown Swiss X Holstein crossbreds, daily fat yield (1.08 kg) and protein yield (0.88 kg) equaled yields for Holsteins, but milk yield was slightly lower (27.6 versus 28.9 kg). For Jersey X Holstein crossbreds, fat yield was equal to Holsteins, but protein yield (0.85 kg) and milk yield (25.7 kg) were lower. With cheese yield pricing, crosses of Brown Swiss or Jerseys with Holsteins may be more profitable than purebred Holsteins if heterosis for health, fertility, and mortality traits are considered. Yields for all other breeds and breed crosses were lower than yields for purebred Holsteins, but feed costs are lower for breeds with smaller body size. Because inbreeding coefficients are increasing by 2 to 3% per decade, heterosis for yield should increase by .6 to .9%. Although genetic progress is slower

within the less numerous breeds, increasing breed differences, current heterosis for yield traits is sufficient to make some dairy breed crosses worth considering. Animals should receive credit for heterosis when considered as mates for another breed. A combined national evaluation of data for all breeds and crossbreds may be desirable but would require an extensive programming effort.

Key Words: Crossbreeding, Heterosis, Dairy cattle

107 Strategies for continual application of MAS in an open nucleus population. A. Stella*¹, G. Jansen², G. Pagnacco³, and P. Boettcher⁴, ¹CERSA-FPTP, Italy, ²CGIL, University of Guelph, Canada, ³University of Milan, Italy, ⁴ANAFI, Italy.

The objectives of this study were to develop and simulate the implementation of several strategies for repeated application of quantitative trait loci (QTL) detection and marker assisted selection (MAS) and to compare the short-term and continual genetic responses. A finite locus model was simulated with 20 QTL randomly distributed across 30 chromosome. Three hundred markers with 6 alleles were evenly spaced across the genome. Allelic effects were sampled from a double exponential distribution. A daughter design was used, every generation, to determine the marker alleles associated with QTL effects. Within family MAS was applied to young bulls, prior to progeny testing, as part of an open nucleus. Young bulls were selected using strategies based on a) the single marker with greatest contrast (BEST1), b) the sum of n greatest contrasts (BESTn), c) the best n contrasts, limited to one per chromosome (LIMn), d) the sum of all contrasts exceeding a given threshold (THRES), and e) the sum of contrasts exceeding a threshold, but limited to one per chromosome (LIMT). Maximum progress was achieved by strategies that selected upon several markers flanking multiple QTL in each generation. When THRES was applied, the mean TBV of selected bulls was increased by 11.98% over conventional selection versus 6.73% for BEST1 in the first generation. On average, 19 marker locations exceeded the 1.96 critical value for THRES. For all approaches, the advantages of MAS decreased to roughly a half by generation five. These decreases occurred because selection decreased the amount of genetic variability in the population and the expected difference between sire alleles at the QTL. The QTL accounting for the greatest proportion of genetic variance in the commercial population was often not selected for in the nucleus, because many nucleus sires were homozygous at that locus. Applying a full genome scan in each generation allowed selection for different QTL across time. By selecting for multiple QTL over time, MAS maintained superiority over conventional selection for many generations.

Key Words: QTL detection, Marker Assisted Selection

108 Superiority of QTL-assisted selection in different dairy cattle breeding schemes. Gamal Abdel-Azim* and A. E. Freeman, Iowa State University.

The effect of varying the system of dairy cattle breeding on the superiority of QTL-assisted selection (QAS) over QTL-free selection is investigated. Stochastic computer simulation was used with realistic structure and proportional parameters to the US Holstein population. QTL-assisted selection was based on breeding values that were estimated by an animal model that accounted for the identified QTL as fixed factors and QTL-free selection was based on a conventional animal model. Three aspects of the superiority of QTL-assisted selection were evaluated: genetic response, accuracy of evaluation, and selection pressure on the favorable QTL allele. Aspects of superiority were examined for active sires, young bulls, bull dams, and commercial cow population. The breeding systems compared were: first a conventional progeny testing plan against a progeny testing plan that employed a nucleus herd. The nucleus herd simulated was a hybrid closed nucleus herd with a hierarchical mating design. Second, early selection of young bulls at the age of 3 and 4 years was compared against conventional waiting plans of 5 years. QAS performed potentially better in nucleus herds than in conventional two-stage selection, and in early selection plans than conventional plans. It was found that QAS performed the poorest for the 4-year plan. In addition, QAS superiority for the favorable allele frequency was very similar to its superiority in terms of genetic response. On the contrary, accuracy superiority trends did not parallel response superiority trends across the systems or across the paths of selection. QAS accuracy superiority consistently decreased with time because of the accumulation

of pedigree and phenotypic information. The study shows that the superiority expected from QAS is highly dependent on the breeding system implemented. The low superiority of QAS observed in conventional progeny testing schemes suggests that limited benefit is to be expected from using QTL information in genetic evaluation without modifying such schemes to maximize the superiority of QAS.

Key Words: QTL-Assisted Selection, Mixed Models, Dairy Cattle Breeding Systems

109 Optimal selection on two quantitative trait loci with linkage. J. C. M. Dekkers*¹, R. Chakraborty¹, and L. Moreau², ¹Iowa State University, Ames, IA, ²INRA, Gif-sur-Yvette, France.

Methods have been developed to optimize selection on a single identified quantitative trait locus (QTL) over multiple generations but in practice multiple QTL must be selected on simultaneously. Our objectives were to develop a method to optimize selection on multiple QTL and to apply it to selection on two linked or unlinked additive QTL. Effects of the QTL were .25 and .375 phenotypic standard deviations for a trait with heritability .25. Initial frequencies of the favorable QTL alleles were .1. Strategies to maximize total or cumulative discounted response (CDR, 10% discount rate) over ten generations were compared to standard QTL selection on the sum of breeding values for the QTL and an EBV for polygenes, and to phenotypic selection. For unlinked QTL, optimal selection resulted in 6.9% greater total and 2.6% greater CDR than standard QTL selection and 2.4% greater total and 5.6% greater CDR than phenotypic selection. Linkage (recombination rate 0.05) between the QTL slightly reduced response for standard QTL and phenotypic selection but increased response for optimal selection, which capitalized on linkage by emphasizing selection on favorable haplotypes. When the objective was to maximize total response after ten generations and QTL were unlinked, optimal selection increased QTL frequencies to fixation in a near linear manner and equal emphasis was given to each QTL, regardless of a difference in effects of the QTL and regardless of linkage. The average emphasis given to individual QTL was, however, not additive. These results demonstrate the ability of optimal selection to capitalize on information on the complex genetic basis of quantitative traits that is forthcoming as a result of advances in molecular genetics.

Key Words: Marker-assisted selection, Quantitative loci

110 Real options analysis applied to dairy cow breeding and replacement decisions. H Groenendaal* and D.T. Galligan, University of Pennsylvania, School of Veterinary Medicine, Kennett Square, PA, USA.

Many investments allow for active management decisions that can improve their value. However, traditional discounted cash flow (DCF) analysis assumes a passive management (as in the marginal net revenue approach) or attempts to value real investment opportunities that have discretionary asymmetrical cash flows by using an inappropriately constant risk-adjusted discount rate (as in dynamic programming). Therefore DCF neglects the value of active management and under-estimates the true value of investment opportunities. However, the real option approach, developed in the financial markets, captures the value of managerial flexibility.

The goal of this presentation is to describe the real options approach. In addition, this analysis will be applied to the evaluation of a simplified hypothetical breeding and replacement decision of a dairy cow. The conclusion from the traditional DCF method was not to invest in breeding the dairy cow and cull her at the end of the current lactation because the value of the next lactation, if the cow got pregnant, was negative (- US dollar 5). In contrast, the real option approach showed insemination was economically attractive, the value of the pregnant cow's next lactation value was positive (US dollar 34). The difference between the value calculated with both methods, (US dollar 39) was attributable to the extra value of active management.

It was concluded that the real options analysis provided an analytical infrastructure that is more appropriate to be used in situations where managerial flexibility exists. Due to the active role of management as well as the volatility in many livestock investments, real option analysis will allow for better valuation than DCF.

Key Words: Real options, Discounted cash flow, Replacement

ASAS/ADSA Food Safety: Bacteria Detection

111 Ionizing radiation effectively destroys Mycobacterium paratuberculosis in milk. Judith Stabel*¹, Charles Waldren², and Frank Garry², ¹USDA-ARS, National Animal Disease Center, Ames, IA, ²Colorado State University, Fort Collins, CO.

Crohn's disease in humans has strong similarities to Johne's disease in cattle, but with a poorly defined etiology. Mycobacterium paratuberculosis, the causative agent of Johne's disease, has been linked as a causal agent of Crohn's disease in humans. However, evidence to date does not prove that Crohn's disease is caused by M. paratuberculosis and may, in fact, be a multifactorial disorder. Regardless, it has become a concern for the dairy industry as consumer confidence has been influenced by reports that pasteurization may not destroy the bacterium. Efforts to eliminate M. paratuberculosis from the food chain would require rigorous control and management programs for this disease on the farm. Although voluntary programs are in place in many states in the US, it will still be many years before the spread of this disease is attenuated. In the meantime, we must rely on methods that guarantee that potential contaminating agents such as M. paratuberculosis are destroyed in food products post-harvest. Studies to determine optimal methods of pasteurization by heat treatment are underway in many countries, including the US. An alternative method of destruction is the use of ionizing radiation. In the present study, we examined the effects of radiation on milk experimentally inoculated with 10⁴ and 10⁸ cfu M. paratuberculosis/ml of milk. Milk was exposed to either 0, 5 or 10 kGy of radiation (1.2 kGy/hr) and cultured for viable M. paratuberculosis. Results from this study demonstrate that M. paratuberculosis was effectively destroyed by gamma radiation at either dose. Thus, ionizing radiation may prove to be an alternative method for destruction of potential contaminants in dairy foods.

Key Words: Mycobacterium paratuberculosis, Milk, Radiation

112 Microbiological and Rheological Characteristics and Their Association with Shelf-life of Fresh Soft Goat Milk Cheese. Young W. Park*¹, Aref Kalantari¹, Diane L. Van Hekken², and M. H. Tunick², ¹Agricultural Research Station, Fort Valley State University, Fort Valley, GA, ²Eastern Regional Research Center, USDA/ARS, Wyndmoor, PA.

Microbiological and rheological characteristics of commercial fresh soft goat milk cheeses were evaluated for their food safety and shelf-life for an extended refrigerated storage period. The soft goat cheeses were purchased from a farmstead grade A goat dairy, and stored at 4°C for 0, 7, 14, and 21 days. Microbiological assays for total aerobic, *E. coli* and coliform, yeast and mold, and *Staphylococcus aureus* counts were performed using 3M petrifilm plates techniques according to the manufacturer's recommended procedures. Rheological parameters were determined using a universal testing machine and a small strain oscillatory analyzer. Total aerobic counts of the soft goat cheeses were too numerous to count (TNTC) regardless of treatments and lengths of storage periods, probably due to the lactobacilli counts. The respective ranges of yeast and mold counts were 10⁴ -10⁶ cells/g and 10³ -10⁴ cells/g cheese, and both counts were increased with storage time. Coliforms, *E. coli* and *S. aureus* were not detectable, while non-coliform organisms such as *Pseudomonas* and many unidentified presumptive *Staphylococcus* species appeared to be present. Rheological properties revealed that cohesiveness of the soft goat cheeses significantly decreased, while viscoelastic properties remained unchanged as aging time progressed. An inverse correlation was observed between the yeast and mold counts and cohesiveness of the tested cheeses. The significant increase in deterioration of the cheese quality at 21 days storage may be attributed to the elevated *Pseudomonas*, yeast and mold counts, which might have accelerated the lipolytic and proteolytic processes in the stored products.

Key Words: Goat, soft cheese, microbiology, rheology, shelf-life

113 Real-time Assessment Of The Microbial Quality Of Fluid Milk Using A Simple Noninstrumental Microrespirometer. Y-H.P. Hsieh*¹, Z. Ren¹, and Y.P. Hsieh², ¹Auburn University, Auburn, AL, USA, ²Florida A & M University, Tallahassee, FL, USA.

An innovative approach using a recently developed non-instrumental microrespirometer for detection of spoilage bacteria in pasteurized fluid

milk was studied. The microrespirometer, which sensitively measures the minute amounts of CO₂ (l/h) evolved by bacterial respiration, efficiently determined the total spoilage bacterial activity in real time (within one hour). The technique was validated using the official Petrifilm total aerobic count (TAC) method in conjunction with the sensory characteristics of the milk sample. In the low microbial growth range (10² - 10³ CFU/ml), the rate of CO₂ evolution was more consistent and sensitive in assessing the microbial quality of the milk than the TAC. The cut-off point for milk suitable for human consumption was set at a CO₂ rate of 25 l/ml/h, corresponding to a viable count approaching 10⁷ CFU/ml. This research demonstrated a novel and economic means of improving the speed of microbial detection and ensuring the high quality and safety of perishable foods such as milk.

Key Words: milk, real-time assessment, microbial quality

114 Comparisons of meat carcass surface bacterial collection efficiencies utilizing a novel wet-vacuum Microbial Sampler and the Sponge method. J. Bruce Bradley* and S. Filomena Saddler, Rocky Mountain Resource Labs, Inc., Jerome, Idaho/USA.

A novel wet-vacuum sampler, Microbial-VacTM (M-Vac), currently under development with NIH funding, was compared to the Sponge (SP) method for collection efficiency of surface bacteria off chilled beef carcasses. The M-Vac allows contained application of sterile, food safe Surface Rinse Solution (SRS) and subsequent retrieval of the liquid and suspended microbes off food surfaces. Microbes present in high numbers (APC) may be detected in recovered liquid aliquots (ca 50ml/100cm²) of SRS. For improved recovery and detection of bacteria present in low numbers, the collected liquid may be filtered through the M-Vac's 0.45µm final filter for rapid or conventional detection and quantification directly on the removable filter. Twenty-four samples were separately collected off adjacent sites of brisket, flank and rump (100 cm²) using the two methods. Sponge samples, pummeled in peptone and M-Vac SRS aliquots were plated on Petrifilm for APC, TCC and ECC. Following SRS filtration, M-Vac filters were removed and placed directly on EMB media for TCC. Results indicate there were no differences (P ≥ 0.05) among sampling sites within methods but the M-Vac collected higher mean APC/s than SP (log₁₀), 3.91 ± 0.51 vs 3.11 ± 0.57 (all sites) P ≤ 0.05 in all cases. No coliforms were detected in diluted liquid samples from either method but low level (1-5 CFU/100 cm²) *E. coli* was confirmed on the M-Vac's filter in 8 of 12 samples. These observations indicate the M-Vac may provide a more efficient, non-destructive sampling method for low-level pathogen collection and detection on meat carcasses, as well as food-prep and processing equipment surfaces.

Key Words: Microbial, Collection, Meat

115 Novel Biosensors for the Rapid Detection of Campylobacter in Various Food Matrices. Richard Obiso* and Jill White, IGEN International, Inc., Gaithersburg, MD.

Campylobacter is considered to be the leading cause of enteric illness in the United States. Symptoms of a Campylobacter infection include mild to severe diarrhea, including loose and watery stools followed by bloody diarrhea. *C. jejuni*, *C. lari*, and *C. coli* represent the three main species that lead to enteric disease in humans, however, procedures to detect these Campylobacter species may take as long as 5 days to complete. Therefore, more rapid methods are required to determine the presence of Campylobacter in food. In this study, the utility of an ORIGEN[®]-based Campylobacter test was evaluated in different food matrices. This technology is based on a technique called electrochemiluminescence, which permits the detection of Campylobacter within an extensive array of samples. The food matrices tested included, poultry products, fruits and vegetables, shellfish, cheese products, milk products, and water samples. These food matrices (100 samples) were tested by microaerophilic incubation in Bolton broth using both 24 h and 48 h enrichment methods, followed by testing using the PATHIGENTM Campylobacter test or B.A.M. standard plating methods. Food samples representative from each matrix were also inoculated with known levels of *Campylobacter jejuni* and tested using the Campylobacter test. The Campylobacter test was able to detect the equivalent of less than 100 CFU/25 g of sample. Detection of Campylobacter was possible in 24 h or in 48 h. The PATHIGEN test performed equivalently when compared

to B.A.M. standard plating methods, however, detection was reduced to 24-48h. Each assay takes approximately 1.5 h after enrichment and can be run simultaneously with other PATHIGEN tests.

Key Words: Campylobacter, Diagnostic, Detection

116 Novel Biosensors for the Rapid Detection of Salmonella Species in Various Food Matrices. Eddie Jefferies*, Shelia Rowe, and Jill White, IGEN International, Inc., Gaithersburg, MD.

Salmonella are implicated in causing 2 to 4 million cases of salmonellosis annually in the United States. Symptoms of a Salmonella infection include nausea, vomiting, abdominal cramps, diarrhea, fever and headache. *S. typhimurium* and *S. enteritidis* represent the two main species that lead to enteric disease in humans, however, procedures to detect these Salmonella species may take as long as 4 days to complete. Therefore, more rapid methods are required to determine the presence of Salmonella in food. In this study, the utility of an ORIGEN[®]-based Salmonella test was evaluated on different food matrices. This technology is based on a technique called electrochemiluminescence, which permits the detection of Salmonella species within an extensive array of samples. Food matrices included, poultry products, fruits and vegetables, shellfish, cheese products, milk products, chocolate, and water samples. 100 samples were tested by pre-enrichment in buffered peptone water followed by selective enrichment in Rappaport Vassiliadis soya peptone broth and testing using the PATHIGEN[™] Salmonella test or B.A.M. standard plating methods. Food samples representative of each matrix were also inoculated with known levels of *Salmonella typhimurium* and tested using the Salmonella test. The Salmonella test was able to detect the equivalent of less than 1 CFU/25 g of sample. The sensitivity of the PATHIGEN test was equivalent to the B.A.M. standard plating methods, however, detection time was reduced to 24-30 h. Each assay takes approximately 1.5 h after enrichment and can be run simultaneously with other PATHIGEN tests.

Key Words: Salmonella, Diagnostic, Detection

ASAS/ADSA Growth and Development: Muscle Growth and Development

118 Cyclic stretch influences p21^{WAF1} promoter activity in myoblasts and myotubes. M.K. Webster*¹ and J.M. Reecy¹, ¹Iowa State University, Ames, IA.

The ability of skeletal muscle to adapt to an imposed workload has been well characterized, while the molecular events underlying this process are less defined. Cyclin dependent kinase inhibitors, such as p21^{WAF1}, play an important role in cell cycle progression. These cell cycle regulators, in conjunction with members of the MyoD family, have been shown to induce the terminal differentiation of myoblasts. In previous studies, p21 expression was dramatically increased after as little as 12 hours of overload, as well as during terminal differentiation. These results suggest that either myoblasts differentiate, thereby increasing p21 expression, or p21 expression in the existing myofibers increases in response to work overload. We hypothesized that there was a stretch-responsive element within the p21 promoter. C2C12 myoblasts, plated at 1250 cells/cm², were transiently transfected with a p21-Luciferase construct. The construct was made by inserting 2.1 kb of 5' p21 promoter upstream from the firefly luciferase gene. Cells were cyclically stretched for 24 or 48 hours with a Flexercell-3000 machine, or no stretch as a control. The stretch protocol consisted of a 20% sine stretch for 3 seconds, followed by ten seconds of rest. This cycle was repeated three times, after which the cells were allowed to rest for 30 minutes. This series was repeated for the duration of the experiments. The promoter activity in myoblasts appears to decrease in response to cyclic stretch. Additionally, C2C12 myoblasts were plated at 20,000 cells/cm², transiently transfected, and induced to differentiate with low serum media for 15 hours. The differentiating myoblasts were then cyclically stretched for up to 48 hours. There was a 6.5-fold increase in promoter activity during differentiation. In addition, p21 promoter activity appeared to increase in response to stretch. We are currently examining the mRNA abundance of p21 un-

117 Comparison of cultivation to PCR-hybridization for detection of Salmonella in porcine fecal and water samples. Ingrid Feder¹, Jerome C. Nietfeld², John Galland³, Teresa Yeary², Jan M. Sargeant³, Richard Oberst³, Mark L. Tamplin¹, and John B. Luchansky¹, ¹U. S. Department of Agriculture, Wyndmoor, PA/U.S.A., ²College of Veterinary Medicine, KSU, Manhattan, KS/U.S.A., ³Food Animal Health and Management Center, KSU, Manhattan, KS/U.S.A..

Salmonella in swine is an economic concern to swine producers and a human health risk. A reliable and rapid technique for *Salmonella* detection in swine feces and water exposed to swine feces would be useful. The purpose of this research was to compare cultivation methods and PCR-based methods for the detection of *Salmonella* in the feces of healthy pigs and in water. In the present study, three cultivation techniques were compared to a polymerase chain reaction (PCR)-hybridization technique for the detection of *Salmonella*. A total of 150 fecal and water samples were tested for the presence of *Salmonella*: 1) 92 fecal samples were pre-enriched overnight in tryptic soy broth (TSB) followed by overnight enrichment in Rappaport-Vassiliadis R10 (RV10) broth; 2) 34 fecal samples were enriched overnight in RV10 broth with no additional enrichment; and, 3) 24 water samples were pre-enriched overnight in 3MC broth followed by overnight enrichment in RV10 broth. For the PCR detection of *Salmonella*, samples were tested after the first overnight enrichment. The DNA was extracted via boiling and concentrated using a Sepharose CL-6B spin column. A total of 65 samples tested positive by both cultivation and the PCR or either method alone. *Salmonella* was detected by both methods in 68.8% of the positive samples pre-enriched in TSB, in 73.3% of the positive samples pre-enriched in 3MC, and in 24.0% of the positive samples enriched in RV10. Using the kappa statistic, agreement was 76% between cultivation with pre-enrichment and the PCR for *Salmonella* detection but was 5.7% when using cultivation without pre-enrichment compared to the PCR. These data provide evidence that the PCR could be used in combination with cultivation to improve *Salmonella* detection as the PCR worked as well or better than culture for delineating positive samples. However, the PCR detected only 72% of those samples which culture identified as positive, indicating that additional improvements are warranted before the PCR replaces cultivation as the gold standard for detection of *Salmonella* from swine.

Key Words: *Salmonella*, PCR-hybridization, Swine

der these same conditions. Based on these results, it would appear that the p21 promoter responds differentially in myoblasts and myotubes to cyclic stretch.

Key Words: p21^{WAF1}, cyclic stretch, skeletal muscle

119 Effect of intramuscular plasmid delivery and electroporation on circulating concentration of the plasmid-encoded reporter gene in the pig. A.G. Van Kessel*¹, B.G. Goldade¹, B.R. Krishnan², M.A. Morsey², L.D. Nelson², and P.J. Gaynor³, ¹University of Saskatchewan, Saskatoon, SK, Canada, ²Pfizer Global Research and Development, Groton, CT, ³Pfizer Global Research and Development, Terre Haute, IN.

The effect of electroporation of skeletal muscle following plasmid injection on expression of a reporter gene was examined using 24 pigs (103.6 ± 0.79 kg BW). Pigs were assigned to one of four treatment groups including a vehicle control (CON) group, a group administered 2 mg plasmid in each of 2 sites (2P), a group administered 2 mg plasmid in each of 2 sites followed by electroporation (2PEP) and a group administered 1 mg plasmid in each of 2 sites followed by electroporation (1PEP). Prior to treatment, all pigs were sedated. The plasmid encoded secreted alkaline phosphatase (SEAP) driven by the CMV promoter and was injected in the right *biceps femoris* muscle suspended in 1 mL Na₂HPO₄ (150 mM, pH 7.2). Twelve electrical pulses (200 volts for 20 msec) were delivered across (1 cm gap) the injection site such that 6 pulses were delivered parallel with muscle fibres and 6 pulses were delivered perpendicular to muscle fibres. Polarity was reversed for 3 pulses delivered in each orientation. Electroporation had no adverse effects on the pigs. SEAP was detected in blood by day 2 following plasmid injection in electroporated pigs with maximal circulating SEAP activity observed

at day 10 and returned to baseline by day 21. Serum SEAP activity, measured in relative light units (RLU), was not significantly increased in CON (88 137) versus 2P (459 131) pigs. Comparison of 2P and 2PEP groups indicated electroporation increased SEAP activity 3.9-fold ($P < 0.001$). SEAP activity was different ($P < 0.05$) on day 7 only, between 1PEP (657 725 RLU) and 2PEP (1 005 619 RLU) treatment groups. Electroporation enhanced plasmid-encoded gene expression and may be an alternative approach to *in vivo* protein delivery.

Key Words: Swine, Electroporation, Gene Therapy

120 Muscle-derived insulin-like growth factor-I alters postnatal growth. J. K. Armstrong*, P. V. Malven, A. L. Grant, and D. E. Gerrard, *Purdue University, 1151 Smith Hall, West Lafayette, IN 47907.*

Insulin-like growth factor-I (IGF-I) regulates postnatal growth in most mammals. The source of this growth factor, however, is a point of much debate as some suggest the primary action of IGF-I results from GH-dependent release from the liver, yet the ability of peripheral tissues to produce IGF-I independently from GH may play an equally important role in growth. Therefore, we crossed three lines of mice: (1) *Little* mice (GH deficient), (2) IGF-I knock-out mice deficient in endogenous IGF-I (eIGF-I), and (3) mice with a muscle-specific actin promoter-driven human IGF-I transgene (tIGF-I), to evaluate the role of muscle-derived IGF-I in GH and/or IGF-I deficient mice. Body weights were recorded at 1, 10, 20, 30, 40, and 60 d postnatal. Progeny were genotyped using PCR. Serum GH and IGF-I concentrations were determined by radioimmunoassay. eIGF-I +/- mice had lower ($P < .01$) body weights than eIGF-I +/+ (wild type) mice after d20. *Little* (-/-) mice were smaller ($P < .0001$) than *Little* wild-type or heterozygotes after d20. Presence of the tIGF-I transgene resulted in increased ($P < .10$) body weights in eIGF-I +/+ mice (d60), eIGF-I +/- mice (d40), *Little* +/- mice (d40), and *Little* -/- mice (d60). The tIGF-I transgene did not change serum GH or IGF-I concentrations, but eIGF-I +/- mice had lower ($P < .0001$) serum IGF-I than wild-type eIGF-I mice. These data suggest both IGF-I alleles are necessary for normal body growth and serum IGF-I concentrations in mice, and that muscle-specific production of IGF-I is capable of increasing body weights in GH and IGF-I deficient mice.

Key Words: Growth hormone, Insulin-like growth factor-I, Mice

121 Effect of an IGF-I transgene on tissue accretion rates in pigs. VG Pursel*¹, AD Mitchell¹, RJ Wall¹, ME Coleman², and RJ Schwartz³, ¹USDA-ARS, Beltsville, Maryland, ²Valentis, Inc., The Woodlands, Texas, ³Baylor College of Medicine, Houston, Texas.

The objective of this research was to determine whether directing expression of IGF-I specifically to striated muscle would alter the rate of lean and fat tissue accretion. Founder transgenic pigs were produced with a fusion gene composed of avian skeletal alpha-actin regulatory sequences and the cDNA encoding IGF-I. A founder transgenic boar (hybrid dam line) was mated to 12 non-transgenic gilts from two hybrid sire lines to produce G1 transgenic (TG) and sibling control progeny (CN). Pigs were provided feed ad libitum from weaning to 120 kg BW. At 90 and 120 kg BW, 31 TG and 39 CN pigs were anesthetized and scanned by dual-energy x-ray absorptiometry (DXA) to estimate fat and lean body composition of the live pigs. At 90 kg TG gilts had 16.4% less fat and 6.2% more lean tissue and TG barrows had 21.1% less fat and 8.4% more lean tissue than respective CN pigs ($P < 0.01$ for each). During subsequent growth from 90 to 120 kg, the rates of fat accretion were 20.6% and 23.7% lower for TG gilts and barrows than for respective CN pigs. Rates of lean tissue accretion were 30.3% and 31.7% higher for TG gilts and TG barrows, than for respective CN pigs. The rates of lean tissue accretion were 632 and 485 g/d for TG and CN gilts and 696 and 529 g/d for TG and CN barrows, respectively (TG vs. CN, $P = 0.0001$). The rates of fat tissue accretion were 242 and 305 g/d for TG and CN gilts and 300 and 393 g/d for TG and CN barrows, respectively (TG vs. CN, $P = 0.0001$). The IGF-I transgene affected progeny of both sire lines similarly in regard to enhancement of lean tissue accretion and reduced fat deposition. These results confirm our earlier findings that the targeting of IGF-I expression to striated muscles had a major impact on lean tissue accretion.

Key Words: Swine, IGF-I, Transgenic

122 IGF-I and analogues can increase growth in artificially-reared neonatal pigs. F. R. Dunshea*¹, C. S. Chung², P. C. Owens³, F. J. Ballard³, and P. E. Walton³, ¹Agriculture Victoria, Victorian Institute of Animal Science, Werribee, Australia, ²Department of Animal Science, Chungbuk National University, Republic of Korea, ³Cooperative Research Centre for Tissue Growth and Repair, Adelaide, Australia.

Exogenous insulin like growth factor-I (IGF-I) has been shown to increase growth rate in neonatal pigs while an analogue of IGF-I, LR3IGF-I, has been shown to be more potent than IGF-I in the rat. Therefore a study was conducted to determine whether IGF-I and LR3IGF-I increase growth in the artificially reared neonatal pig. Eighteen pigs (2 kg initial weight) pigs were infused with control, IGF-I (8 $\mu\text{g/h}$) or LR3IGF-I (8 $\mu\text{g/h}$) via osmotic pumps. After 9 days an additional pump was inserted to increase the infusion rates of each of the growth factors (16 $\mu\text{g/h}$) for a further 9 days, after which time the pigs were slaughtered. Pigs were offered bovine milk ad libitum. Neither IGF-I nor LR3IGF-I had any effect upon daily gain over the first 9 days of the study. However, over the second 9 days of the study, daily gain was increased in LR3IGF-I infused pigs (386 v. 457 g/d, $P < 0.01$), and tended to be increased in pigs infused with IGF-I (386 v. 413 g/d, $P = 0.15$). As a result pigs infused with LR3IGF-I were heavier than the control pigs at slaughter. Milk intake was not different during the first 9 days of the study but was significantly greater in pigs infused with growth factors over the second half of the study (2905 v. 3407 g/d, $P < 0.01$). Pigs treated with LR3IGF-I had a larger spleen (18.9 v. 27.5 g, $P < 0.001$) and tended to have a larger liver (286 v. 319g, $P = 0.078$), small intestine (329 v. 383 g, $P = 0.10$) and combined small intestine and liver (614 v. 701 g, $P = 0.062$) weight. Plasma IGFBP3 concentrations were highly correlated ($R = 0.85$) with average daily gain over the 3 days preceding blood sampling. In conclusion, exogenous IGF-I and particularly LR3IGF-I can increase growth rate and visceral development in ad libitum fed artificially-reared pigs. At least part of the cause was an increase in milk consumption of infused piglets.

Key Words: IGF-I, Pig, Neonate

123 A GnRF vaccine (Improvac[®]) and porcine somatotropin have synergistic and additive effects on growth performance in group-housed boars and gilts, respectively. W. T. Oliver*¹, I. McCauley², R. J. Harrell¹, D. Suster², and F. R. Dunshea², ¹North Carolina State University, Raleigh, NC, ²Agriculture Victoria, Victorian Institute of Animal Science, Werribee, Australia.

Two hundred and twenty four pigs (112 boars, 112 gilts) were used in a 2x2x2 factorial design, with the factors being vaccination with a GnRF vaccine, Improvac[®] (I; 0 or 2 ml at 13 and 17 wks of age), porcine somatotropin (pST; 0 or 5 mg/d from 17 wks of age), and gender. Pigs were weighed and feed disappearance was measured from 17 wks of age until slaughter at 21 wks of age. Body composition was measured by dual-energy X-ray absorptiometry at 17 and 21 wks of age. At slaughter, boars were heavier than gilts (100.7 vs 95.1 kg, $P < 0.008$). ADG was increased by both I (1109 vs 1244 g/d, $P < 0.001$) and pST (1109 vs 1199 g/d, $P < 0.001$). Boars treated with both I and pST gained at a faster rate (1404 g/d) than control and pST treated pigs ($P < 0.001$), and tended to grow at a faster rate than pigs receiving I alone ($P < 0.08$). Overall, I increased ADG in gilts (1000 vs 1166 g/d, $P < 0.001$). However, ADG for gilts treated with both pST and I was not significantly different from I or pST treated pigs. Treatment with I increased feed intake by 18 % ($P < 0.01$), but treatment with both I and pST resulted in feed intakes similar to pigs receiving neither treatment ($P > 0.5$). Treatment with I increased fat gain (217 vs 301 g/d, $P < 0.001$), while fat gain for pST treated pigs was reduced (170 g/d, $P < 0.001$). Pigs receiving both I and pST had fat accretion rates similar to control pigs ($P > 0.4$). While treatment with I or pST alone had no effect on lean gain in boars ($P > 0.2$), boars treated with both I and pST tended to have higher lean accretion rates than control boars (707 vs 782 g/d, $P < 0.09$). Treatment of gilts with pST increased lean gain (485 vs 652 g/d, $P < 0.001$), but no difference was observed in gilts treated with I. Gilts treated with I and pST accrued lean mass at a rate similar to pST treated pigs (703 vs 652 g/d, $P > 0.2$). In conclusion, the concomitant use of I and pST improves growth performance in boars and gilts.

Key Words: GnRF, pST, Swine

124 Regulation of selection-induced growth hormone expression in porcine single trait selection lines. M.F.W. te Pas*, J.W.M. Freriksen, A.J.H.M. van Bijnen, C.L.M. Gerritsen, T.J. van den Bosch, F.J. Verburg, A.H. Visscher, and K.H. de Greef, *Institute for Animal Science and Health, ID-Lelystad.*

Selection for increased growth rate or decreased fat deposition in pigs is associated with changed growth hormone (GH) plasma levels. The molecular mechanisms regulating selection-induced changes remain largely unknown. This study aims at investigating selection-related changes in individual components of the GH expression. Associations between performance and GH expression parameters were evaluated in 2 pig selection lines selected for increased growth rate (F-line), or decreased back fat thickness (BFT) (L-line). We investigated changes in the mRNA levels of GH and its pituitary-specific transcription factor (Pit-1) in the pituitaries of slaughter pigs. In both lines GH and Pit-1 mRNA levels increased 50 % each generation. GH mRNA levels are pulsatile in vivo. GH mRNA levels were associated with BFT and growth rate in both lines. Pit-1 mRNA level was associated to BFT in the L-line. When GH and Pit-1 were fitted together in the model GH mRNA levels were significantly associated with growth rate and BFT. GH mRNA levels are directly associated with genetic constitution for BFT, but less or not with growth rate. GH blood plasma pulsatile pattern is characterized by (1) maximum peak value, (2) area under the curve, (3) pulse width, and (4) pulse interval. Both lines showed a declining GH peak maximum level and area under the GH curve. GH pulse width was not affected by selection. In both lines the pulse interval declined during selection, indicating that the number of pulses per day increased during selection with 1 pulse per 24 h per generation. Growth rate was associated with the GH plasma baseline value in both lines. Area under the curve and GH baseline level was significantly related to BFT. Line-specific effects were found for the baseline levels in the F-line. The results suggest that selection-induced GH synthesis is probably not sufficient for demanded blood plasma secretion resulting in smaller GH peaks and increased peak numbers per day.

Key Words: Pig, Growth Hormone, Expression

125 Cloning, mapping, and functional analysis of porcine pituitary homeodomain transcription factor genes. S.J. Rhodes*¹, K.W. Sloop¹, G.E. Parker¹, T.P.L. Smith², A.D. Showalter¹, A.L. McCutchan Schiller¹, J.R. Blanton Jr¹, and G.A. Rohrer², ¹Indiana University Purdue University Indianapolis, ²US MARC Nebraska.

Hormones secreted from the pituitary gland mediate regulation of growth, lactation, reproduction, the stress response, and metabolic homeostasis. Recent studies have identified transcription factors that regulate the development and function of the pituitary gland in mice and humans. Our goal is to understand the molecular events that regulate pituitary development in swine. We have cloned, mapped, and analyzed the genes encoding the porcine Lhx3 (pLhx3) and Prop-1 (pProp-1) homeodomain transcription factors. In mice, Lhx3 is expressed in the developing nervous system, and then is restricted to the pituitary. Prop-1 expression is pituitary-specific in rodents. The pLhx3 and pProp-1 proteins are conserved within their protein/protein interaction and DNA-binding domains but exhibit less conservation outside these motifs. Assay of gene expression in whole early porcine embryos by RT-PCR revealed that the pLhx3 gene is activated at the time of neurogenesis. It then displays a biphasic expression pattern with expression increasing during the establishment of the pituitary and at the time of hormone gene activation. By contrast, pProp-1 is only observed at the times of pituitary organogenesis and then is down regulated to low levels. Northern analysis demonstrated that the pLhx3 gene produces a rare transcript in the adult pituitary. RNase protection analysis detected several pProp-1 mRNAs at low levels in the pituitary gland; expression was not found in other endocrine organs. Porcine Lhx3 activated the alpha-glycoprotein and prolactin promoters in transfection assays. Recombinant pLhx3 and pProp-1 proteins specifically bound to DNA sites in gelshift assays, and the pLhx3 protein specifically interacted with Pit-1 and other partner proteins in solution binding assays. We have mapped the protein elements required for the nuclear localization of pLhx3 and have demonstrated that pLhx3 is associated with the nuclear matrix. Genetic mapping experiments placed the pLhx3 and pProp-1 genes on the q arms of pig chromosomes 1 and 2, respectively.

The mapping and analysis of swine pituitary regulatory genes will provide candidate genes for genetic analysis of growth, reproductive, and metabolic traits. Supported by USDA.

Key Words: Growth, Gene, Transcription

126 Purification of porcine β -casein from milk by liquid chromatography, N-terminal sequencing, and antisera development. Adam C.W. Kauf* and Ronald S. Kensinger, *Pennsylvania State University, University Park, Pennsylvania.*

Sow's milk is not capable of supporting the genetic potential for growth of modern piglets. A better understanding of the regulation of milk protein synthesis is desirable to improve sow milk, but is hindered by a lack of reagents to directly measure porcine milk proteins. Our objective was to purify porcine β -casein from sow's milk, determine N-terminal amino acid sequence, and develop specific polyclonal antisera against porcine β -casein. Milk was collected by hand milking from an oxytocin-treated crossbred Yorkshire sow on d 27 of lactation. Milk was defatted by centrifugation (5,000 x g, 15 min), and the casein fraction precipitated by incubation at pH 4.6. A casein-enriched fraction was isolated by centrifugation (5,860 x g, 60 min), washed three times, and lyophilized for storage at -20 °C. For further fractionation, it was then dissolved (24 mg/ml) in 4 M Urea and 0.01 M Imidazole at pH 6.75. A volume of 1.5 ml was applied (1 ml/min) to a 5 ml Mono Q anion-exchange column (Bio-Rad Laboratories), and eluted by a stepwise gradient of NaCl between 0 and 500 mM in Urea/Imidazole buffer. Fractions from the 165 mM NaCl step were collected and pooled from five chromatographic runs. β -casein (9 mg) was isolated and assessed by electrophoresis (SDS-PAGE with 4 M Urea) to be greater than 95 % pure. Direct sequencing of the 14 N-terminal amino acids by Edman degradation yielded RA-KEELNASGETEV, which confirms the sequence predicted by Alexander and Beattie (1992) from cDNA analysis. β -casein (400 ug) was mixed with complete Freund's adjuvant and injected into rabbits, followed by three boosters (200 ug) with incomplete Freund's adjuvant at four week intervals. Antiserum from one rabbit on day 112 after primary immunization detected 100 ng β -casein by Western blot procedure when used at dilution of 1:2,000,000. A goal is to use this antiserum to detect subtle changes in β -casein secretion by porcine mammary tissue.

Key Words: porcine β -casein, anion-exchange chromatography, polyclonal antisera

127 Effect of dexamethasone treatment on growth in neonatal swine. J. S. Seaman*¹, E. P. Berg¹, T. J. Safranski¹, and J. A. Carroll², ¹University of Missouri, Department of Animal Sciences, ²Animal Physiology Research Unit, ARS-USDA, Columbia, MO.

We have previously reported that dexamethasone (Dex) treatment at birth enhances pre-weaning growth in piglets. The objective of the present study was to evaluate the effects of Dex treatment at birth on post-weaning piglet growth. Sixty-four crossbred piglets were assigned according to birth weight and sex to receive either sterile saline (Control; n=16 males and 17 females) or Dex (2 mg/kg body weight; n=14 males and 17 females) i.m. within 1 hour of birth. Using ANOVA, the statistical model included analysis of treatment, sex, and treatment x sex interactions for weight and ADG. Birth weights ($1.543 \pm .270$ kg) did not differ between Dex and Controls ($P > .99$) or males and females ($P > .67$). Weaning weights (21 days of age) were increased ($P < .03$) for Dex piglets (7.72 ± 1.10 kg) compared to Controls (7.14 ± 1.15 kg). At 7 weeks of age, piglets were moved out of the nursery. There was a treatment x sex interaction in 7-week weight ($P < .07$) such that no difference existed between Dex and Control females; however, Dex males (17.65 ± 2.20 kg) were heavier ($P < .08$) than Control males (15.97 ± 2.67 kg). ADG through weaning was increased ($P < .03$) in Dex piglets ($.293 \pm .048$ kg/d) compared to Controls ($.267 \pm .047$ kg/d). There was a treatment x sex interaction ($P < .08$) for ADG from birth to 7 weeks of age. No effect of Dex treatment was observed in females ($P > .59$), however, a trend was observed in males ($P < .08$) such that Dex increased ADG compared to Controls. Further research is underway to determine if this growth increase is maintained through the grow-finish phase, and if there are effects associated with carcass quality in Dex treatment. Given that the growth rate of the neonatal pig is considered to be less than half of its potential, the use of hormonal therapies such as Dex at birth to enhance growth rates could prove to be of significant economical importance to the swine industry.

Key Words: Dexamethasone, growth, piglets

128 Involvement of the type I and type II glucocorticoid receptors (GR) in growth hormone (GH) cell differentiation (GHDIFF) during chicken embryonic development. I. Bossis* and T.E. Porter, *University of Maryland, College Park MD USA.*

GHDIFF occurs around day 14 of chicken embryonic development (e14) and is coincident with maturation of the adrenal glands. We have previously shown that corticosterone (CORT) can induce premature GHDIFF both *in vitro* and *in vivo*. In the present study, the GRs mediating the effects of CORT on GHDIFF were identified. Pituitary cells isolated from e12 embryos were cultured in the presence of vehicle (A), CORT at 1 nM (B), the type II GR antagonist ZK-98299 at 10 μ M (C) and B + C in combination (D). Immunocytochemistry for GH was used to assess GHDIFF. Treatment with CORT significantly increased the population of somatotrophs, but the effect was not blocked by ZK-98299 (1.2 ± 0.3 , 22.0 ± 2.1 , 1.0 ± 0.2 and 19.8 ± 1.9 % of all pituitary cells for A, B, C and D, respectively; $P \leq 0.05$, $n=4$ experiments). However, treatment with ZK-98299 clearly reduced the intensity of GH staining. Subsequently, several steroids were tested for their ability to induce GHDIFF *in vitro*. Only glucocorticoids (CORT and dexamethasone) and aldosterone (ALDO) were effective, suggesting that both the type I (mineralocorticoid) and type II (glucocorticoid) GR might be involved. To test this hypothesis, e12 pituitary cells were cultured in the presence of vehicle (A), CORT at 1 nM (B), ALDO at 0.1 nM (C), CORT plus the mineralocorticoid receptor antagonist spironolactone (SPIRO) at 10 μ M (D), ALDO plus SPIRO (E), ALDO plus ZK-98299 at 10 μ M (F), CORT plus ZK-98299 and SPIRO at 10 μ M each (G) and ALDO plus ZK-98299 and SPIRO (H). Induction of GHDIFF by CORT and ALDO was not blocked by SPIRO or ZK-98299 alone. However, it was completely abolished in the presence of both GR antagonists (1.8 ± 0.3 , 23.6 ± 3.1 , 21.7 ± 2.6 , 20.9 ± 2.3 , 23.0 ± 2.3 , 22.7 ± 2.9 , 3.4 ± 0.6 and 2.5 ± 0.5 % of all pituitary cells for A, B, C, D, E, F, G and H, respectively; $P \leq 0.05$, $n=4$ experiments). We conclude that both the type I and type II GR mediate steroid-induced GHDIFF and that either GR type is sufficient for this response.

Key Words: Somatotroph differentiation, Glucocorticoid receptor, Mineralocorticoid receptor

129 Gene expression in sexually dimorphic muscles in sheep. R.G. Mateescu* and M.L. Thonney, *Cornell University, Ithaca, NY.*

Testosterone is known to act differentially on skeletal muscle from different regions. Two genes likely to mediate the testosterone effect are insulin-like growth factor-I (IGF-I), an important growth regulator acting in an autocrine and paracrine way, and androgen receptor (AR), as receptor density could account for differential muscle growth. Another muscle-specific gene that may play a role in differential muscle growth is myostatin (MSTN), a member of the transforming growth factor-beta superfamily, shown to be a negative regulator of skeletal muscle mass. The objective of this study was to quantify and compare the expression of these three genes in two different skeletal muscles in sheep. Eleven Dorset rams were slaughtered after reaching puberty and total RNA was extracted from samples of semitendinosus (ST) and splenius (SP) muscles. IGF-I mRNA was measured using competitive reverse-transcription-polymerase chain reaction (RT-PCR). AR and MSTN mRNA were measured by ribonuclease protection assay (RPA) with standard curves. The means (attomoles/ μ g RNA) for SP and ST muscles were 1.39 and 1.02 (SE = 0.14), 4.05 and 2.96 (SE = 0.24), and 4.30 and 3.85 (SE = 0.37) for IGF-I, AR, and MSTN respectively. The difference between the two muscles was significant for IGF-I ($P < 0.1$) and AR ($P < 0.01$) mRNA levels with higher expression in the SP but not for MSTN ($P > 0.4$). Our results show that locally produced IGF-I and the regulation of AR expression may be important for sexually dimorphic muscle growth patterns.

Key Words: muscle, gene expression, sheep

130 The Effect of Stage of Growth and Implant Exposure on Carcass Composition and Quality in Steers. K.W. Bruns*, R.H. Pritchard, and T.A. Wittig, *South Dakota State University, Brookings, SD.*

Angus and Angus x Limousin steers ($n=45$) were used to evaluate the influence of an estradiol-trenbolone acetate implant (revalor-s) on the

relationship between percent intramuscular fat content (PIMF) and carcass composition when administered at specific stages of growth. Treatments were as follows: NI) control No Implant; EI) Early Implant, d 1, BW=295 kg; or DI) Delayed Implant, d 56, BW=385 kg. Steers were procured at weaning and were backgrounded (40 d) prior to the trial. Steers were fed a 90% concentrate diet for 150 d. Serial harvest was conducted at d 1 ($n=5$), d 56 ($n=10$) and at the end of the trial ($n=30$). Rib sections (9-10-11) were removed and analyzed for fat, protein, and moisture content to predict whole carcass composition. Regression equations were developed to quantify changes in carcass characteristics and composition throughout the feeding phase. At d 56 ($n=10$) EI increased HCW vs. NI (NI 227 vs. EI 243 kg; $P < .05$). Backfat, REA, YG, marbling score as well as whole carcass protein (%) and whole carcass fat (%) were not different. At harvest implants (I) increased ($P < .10$) final body weight (532 vs. 541 kg) and HCW (341 vs. 349 kg). Implants increased REA (75.4 vs. 82.74 cm^2 ; $P < .01$) and decreased KPH (3.5 vs. 3.2%; $P < .10$). Yield grade components HCW, BF, REA, and KPH increased linearly. The subjective maturity and marbling scores were not affected by treatment and increased in a linear fashion. Treatment had no effect on the whole carcass proportions of fat, protein, or water. The PIMF of the L. dorsi was reduced ($P < .10$) by EI and was unaffected by DI (NI 5.1, EI 4.0, DI 4.8%). The PIMF content increased linearly and the slope of development was greater ($P < .10$) for NI vs EI. These data indicate that implanting will improve carcass weight and REA with no effect on carcass composition. Early implant exposure tended to reduce the rate of PIMF development but delaying implant until 385 kg BW increased carcass production without decreasing PIMF content.

Key Words: Beef, Implant, Carcass Composition

131 Lipogenic activity and adipose tissue cellularity in steers fed casein-formaldehyde-protected starch and(or) canola lipid. C. D. Gilbert*, D. K. Lunt, and S. B. Smith, *Texas A&M University, College Station, TX.*

Eighteen Brangus steers of similar live weight were assigned randomly to one of three dietary treatment groups: cracked corn (Corn), casein-formaldehyde-protected Canola Lipid (CL), or casein-formaldehyde-protected Marble Plus (MP). The purpose of the study was to determine if feeding protected starch and lipid increased lipogenic enzyme activities in i.m. adipose tissue more than in s.c. adipose tissue, thus increasing marbling scores without increasing yield grade. All diets were equally balanced for ME (291 Mcal/kg), crude protein (12.5%), and dry matter (89%). Ether extract was 3.7, 6.9, and 6.9% for the Corn, CL, and MP diets, respectively. The CL and MP diets provided equal amounts of protected lipid (3.3%). The MP also contained 3.7% protected starch. Steers were fed their respective diets for 126 to 130 d before slaughter. Beef carcasses from steers fed Corn, CL, or MP did not differ in yield grade or marbling score ($P \geq 0.23$). Percentage KPH fat was higher ($P < 0.05$) for CL and MP carcasses than for Corn carcasses. Peak diameter (154 vs 98 μ m) and volume (160 vs 112 pL) were greater in s.c. than in i.m. adipose tissue ($P < 0.05$). Subcutaneous adipocyte peak diameter tended ($P < 0.08$) to be greater in CL steers (130 μ m) than in Corn steers (120 μ m), but peak volume did not differ ($P = 0.55$) among treatments. There were no treatment x tissue interactions for adipocyte volume or cells/g ($P > 0.59$). The addition of lipid to the diets (CL and MP combined effects) increased peak adipocyte diameter ($P = 0.03$). The activities of 6-phosphogluconate dehydrogenase, glucose-6-phosphate dehydrogenase, NADP-malate dehydrogenase, and fatty acid synthetase did not differ among treatment groups for either s.c. or i.m. adipose tissue ($P > 0.05$). We were not able to demonstrate a direct effect of protected starch and lipid on i.m. or s.c. lipogenic enzyme activities, marbling score, or yield grade.

Key Words: Steers, Lipogenesis, Protected Fat

132 Novel effects of nutrition on reproduction in lactating dairy cows. M. C. Wiltbank*, R. Sartori, S. Sangsritavong, H. Lopez, J. M. Haughian, P. M. Fricke, and A. Gumen, *Department of Dairy Science, University of Wisconsin-Madison.*

A number of reproductive parameters are altered in lactating dairy cows including: twinning rate, expression of estrus, conception rate, pregnancy loss, and incidence of anovulation. We hypothesized that the high feed consumption associated with lactation has fundamentally altered reproductive physiology due to increased metabolism of steroids. We evaluated liver blood flow and steroid metabolism under different physiological conditions using continuous infusion of bromosulfothalein (90% metabolized by one pass through liver) and/or estradiol and progesterone. In lactating or non-lactating cows, acute feeding produced an increase in liver blood flow of 20-30% that was maximal by 2 h after feeding. There was a corresponding decrease of 30% in circulating estradiol and progesterone concentrations following acute feeding of cows continuously infused with steroids. The baseline liver blood flow was much greater in lactating (1600 l/h) as compared to non-lactating (800 l/h) cows. Similarly, estradiol and progesterone metabolism was much greater in lactating as compared to non-lactating cows. Analysis of normal estrous cycles showed striking differences in lactating cows vs. heifers that are consistent with high steroid metabolism. Peak serum estradiol near estrus was lower in single-ovulating lactating cows (7.15 pg/ml) than heifers (9.46) in spite of larger preovulatory follicle diameter in cows (17.45 mm) than heifers (14.8.2). Similarly, circulating progesterone concentrations were lower for cows than heifers from d 5 to 14 of the estrous cycle (on day 14: 4.1.3 vs. 6.1.4 ng/ml); whereas, luteal volume was greater for cows than heifers (on day 14: 8272932 vs. 5415276 mm³). There were also differences in double ovulation rate (cows-25.0%; heifers-1.8%) and embryo quality on day 5 after normal ovulation (n = 27-28 per group each flushed 3 different times). The percentage of degenerated embryos (Grade 5) was greater (p<0.05) in lactating cows (61.9%) vs. heifers (6.3%) during summer or comparing lactating (41.7%) vs. non-lactating cows (17.6%) during winter. Thus, changes in reproductive physiology may be a consequence of the high feed consumption, high liver blood flow and resulting increase in steroid metabolism associated with high milk production.

Key Words: Reproduction, Liver blood flow, Progesterone

133 The influence of nutrient intake on ovarian form and function in meat-type chickens. F. E. Robinson*¹, R. A. Renema¹, and M. J. Zuidhof², ¹University of Alberta, ²Alberta Agriculture, Food and Rural Development.

The chicken is an ideal model in which to examine ovarian form and function, including follicular steroidogenesis, recruitment, yolk deposition, atresia and ovulation rate. Meat-type chickens that have been intensively selected for appetite exhibit very fast rates of growth. These stocks are reproductively unfit when allowed to feed ad libitum. Our research has focussed on the degree of feed restriction during rearing and lay, as well as the rate of change in feed intake during sexual maturation (SM) on the above mentioned ovarian parameters in breeding stock. During SM, dietary energy allocation to pullets is increased from approx. 285 kcal/day (20 wk) to 460 kcal/day (30 wk). Birds that are allocated this increase quickly, and early during this period have at least one extra large yellow follicle (LYF). This excess follicular development is associated with a reduction of about 10 eggs, as under estrogen domination following photostimulation (PS), hepatic vitellogenesis partitions excess dietary energy to follicular development. Considering the increased gonadotrophin levels seen in over-fed pullets, it is hypothesized that increased estrogen output was stimulated. Increased estrogen levels stimulate hepatic fatty acid synthesis and the formation of phospholipids and proteins to package lipid for yolk deposition. Recently, the consequences of over-feeding BB females for one of seven 14-d periods during the period from 18 to 32 wk of age were investigated. It was observed that the most critical period for exposing pullets to a bonus feeding allocation (30 g more feed/bird/d) was between 14 and 28 after PS. It is proposed that this period represents the time of maximal sensitivity of hepatic lipogenesis to circulating estrogen. Plasma levels of FSH and LH increase within 48 h of PS in all birds and levels are higher in heavy weight birds. These heavy birds reach sexual maturity more quickly and have a greater number of LYF than do small birds.

Increased plane of nutrition can double the initial increases in plasma levels of FSH and LH and further accelerate SM. Increased follicular development is not advantageous, as evidenced by significantly lower egg output in aggressively fed flocks.

Key Words: Chicken, Ovarian morphology, Follicular recruitment

134 Relationships between Bovine follicular steroids and components of the extracellular matrix. C.M. Field*¹, A.R. Williams¹, A.B. Moore¹, J.N. Oyarzo², M.E. Bellin², and R.L. Ax², ¹Mississippi State University, Starkville, MS, ²University of Arizona, Tuscon, AZ.

Objectives were to confirm presence of TIMP-2 (T2) on surface membranes of bovine follicular cells, determine the relationship of estradiol-17 β (E), progesterone (P), and glycosaminoglycans (GAGs) to T2 in follicular development, and quantify binding of T2 in follicular content. Ovaries were obtained within 30 minutes of slaughter or by ovariectomy. Follicles (n=441) were aspirated from ovaries and follicular fluid and follicular cells separated by centrifugation, and frozen. E and P concentrations in individual follicles were determined by RIA from follicular fluid. Follicles were classified into 4 groups by high/low E and P and large/small size (n=40). Atresia was defined by low E concentration. Follicular fluid GAGs were determined spectrophotometrically using an Alcian blue dye procedure. Granulosa cell content per follicle was quantified using a Pierce BCA protein assay and spectrophotometry. The quantity of T2 present was measured with a fluorometer after incubation with fluorescent-labeled human T2 antibody at 210 μ g/ml per sample. Data were analyzed using SAS GLM procedures to determine relationships of E and P to GAGs and T2 expression and correlation procedures to establish relationship of T2 to GAGs. An inverse relationship between T2 and GAGs to E and P was revealed (P<.05). Regardless of size, high E and P follicles had low GAGs and T2 binding, while low E and P follicles displayed elevated GAGs and T2 binding. The amount of T2/ μ g protein indicated a trend toward additional T2 binding on follicular cells from large atretic follicles, compared to healthy large follicles and small atretic follicles (P<.10). A strong relationship (r=0.85) between T2/ μ g protein and GAGs existed in large, high E follicles. Results confirmed follicle health was related to T2 and GAG expression, with atretic follicles, on the basis of steroid concentrations, displaying higher GAGs and T expression.

Key Words: Bovine, Follicle, TIMP-2

135 Relationship between preovulatory follicle growth and postovulatory luteal function in the cow. GE Mann*¹, ECL Bleach², GR Starbuck¹, and MD Fray³, ¹University of Nottingham, Sutton Bonington, Loughborough, UK, ²University of Reading, Whiteknights, Reading, UK, ³Institute for Animal Health, Compton, Newbury, UK.

In dairy cows the timing and strength of the postovulatory progesterone rise is a key determinant of early embryo development and survival. The aim of this study was to determine whether postovulatory luteal function is related to preovulatory follicle development. Luteal regression was synchronized in 25 non-lactating Holstein Friesian cows which subsequently underwent daily trans rectal ultrasonography to determine the growth pattern and size of the ovulatory follicle. Following ovulation, daily plasma samples were collected for 6 days to determine progesterone concentrations. The mean (sem) diameter of the ovulatory follicle rose from 10.9 \pm 0.8 mm at luteolysis to 15.9 \pm 0.5 mm at ovulation 4.0 \pm 0.2 days later. There was a significant relationship between initial follicle diameter and time to ovulation with smaller follicles taking longer to ovulate (r² = 0.63; p<0.001). The mean plasma concentration of progesterone (from days 4-6 post ovulation) increased significantly with increasing initial (r² = 0.34; p<0.01) and final (r² = 0.24; p<0.05) diameter of the ovulatory follicle and decreased with increasing time from luteolysis to ovulation (r² = 0.22; p<0.05). The mean interval from ovulation to the onset of the postovulatory progesterone rise (>1ng/ml) decreased with increasing initial (r² = 0.34; p<0.01) and final follicle diameter (r² = 0.22; p<0.05) and increased with increasing days to ovulation (r² = 0.34; p<0.01). The results demonstrate that increased progesterone secretion by the developing corpus luteum is related to the ovulation of a larger follicle that took less time to ovulate. Whether it is

follicle size or time to ovulation that is the more important determinant of subsequent luteal function remains to be determined.

Key Words: Cow, Follicle, Corpus Luteum

136 Effects of Acute Nutritional Restriction of Beef Heifers on LH in serum and Anovulation. C. A. Lents*, F. J. White, L. N. Floyd, N. H. Ciccioli, I. Rubio, and R. P. Wettemann, *Department of Animal Science, Oklahoma Agricultural Experiment Station.*

Angus x Hereford heifers (BCS = 5.5 ± 0.1 ; 387 ± 7 kg BW) exhibiting normal estrous cycles at 15 mo of age were used to determine the effects of acute nutritional restriction on LH in serum and the incidence of anovulation. Heifers were maintained in individual pens and adapted to a 1.2 x maintenance (M) diet for 10 d. On d 0, heifers were randomly assigned to 0.4 M (n = 16) or 1.2 M (n = 7). Heifers were treated with PGF 2α on d -10, 0, and 10. Daily blood samples were obtained by tail venipuncture and progesterone in plasma was quantified. Jugular catheters were inserted on d 8. Blood samples were collected every 10 min for 8 h on d 9, 10 and 11, and LH in serum was quantified. Beginning on d 12, blood samples were collected from 0.4 M (n = 9) and 1.2 M (n = 4) heifers every 4 h for 48 h to quantify estradiol in plasma and the ovulatory surge of LH. Heifers with plasma progesterone less than 0.5 ng/mL on d 14 to 21 were classified as anovulatory. On d 12, 0.4 M heifers weighed less ($P < 0.01$) than 1.2 M heifers (353 ± 9 kg vs 391 ± 7 kg, respectively), but BCS was similar for 0.4 M and 1.2 M heifers (5.4 ± 0.1). On d 14, 44% (4 of 9) of 0.4 M heifers were anovulatory and all 1.2 M heifers ovulated. Concentrations of LH in serum and frequency of LH pulses on d 9, 10, or 11 were not influenced by treatment. Anovulatory heifers lacked an ovulatory surge of LH and concentrations of estradiol were similar and minimal on days 2, 3, and 4 after PGF 2α (1.1 ± 0.1 pg/mL). Heifers on 1.2 M had a preovulatory increase in plasma estradiol (2.7 ± 0.4 pg/mL) preceding the ovulatory surge of LH. In conclusion, acute nutritional restriction for 14 d induced anovulation in 44% of heifers, did not influence serum concentrations of LH or frequency of LH pulses during follicular growth, but inhibited the proestrous increase in estradiol and the ovulatory surge of LH.

Key Words: Heifers, Nutrition, LH

137 Estradiol benzoate (EB) inhibits secretion of LH and induces atresia of dominant follicles within 36 hours in cyclic heifers. C.R. Burke*^{1,2}, S. Morgan², M.L. Mussard¹, D.E. Grum¹, and M.L. Day¹, ¹The Ohio State University, Columbus OH, ²Dexel Ltd, Hamilton, New Zealand.

The aim of this study was to characterize LH secretion and timing of functional atresia in dominant follicles (DF) of cyclic heifers treated with EB. At $5.6 \pm .1$ d after estrus, heifers received 1 mg EB/500 kg BW (designated h 0; T; n=15) or remained untreated (C; n=15). Ovarian structures were monitored by ultrasonography at least daily from estrus to ovariectomy or new follicle wave emergence. Blood samples were collected every 20 min for 12 h beginning at h -12, 0, 24 and 48 from seven heifers in each treatment to characterize LH secretion. Four heifers from each of these groups were ovariectomized 12 h after new wave emergence. The remaining eight heifers per treatment were ovariectomized at either h 12 or 36. Concentrations of estradiol-17 β (E $_2$) and progesterone (P $_4$) were determined in the fluid of DF. Maximum diameter of DF was less in the T ($12.0 \pm .8$ mm) than the C ($14.0 \pm .4$ mm) treatment (treatment x time; $P < .01$) but the interval to new wave emergence ($4.6 \pm .2$ d) was similar among treatments. Mean E $_2$ and E $_2$:P $_4$ ratio in DF of T heifers at 36 h (48.6 ± 4.25 ng/ml and $2.37 \pm .6$) was less ($P < .01$) than in C heifers at 36 h (258.13 ± 26.7 ng/ml and $7.3 \pm .7$), and comparable ($P > .1$) to that in C heifers after a new follicle wave had emerged (27.8 ± 17.6 ng/ml and 1.3 ± 1). Mean concentrations of LH and amplitude of LH pulses were lower in the T than C treatment at h 24 and 48 (treatment x time, $P < .05$) while LH pulse frequency was similar between treatments. Maximum P $_4$ in plasma after treatment was lower ($P < .01$) in T ($3.2 \pm .2$ ng/ml) than C treatment ($4.87 \pm .5$ ng/ml). The results indicate that EB-induced atresia of dominant follicles is achieved by 36 h and is accompanied by a reduction in LH pulse amplitude and mean concentration. It is also suggested that the interval from EB treatment to emergence of a new follicle wave is not entirely dependent on the functional status of the present DF.

Key Words: Estrous synchronization, Follicular atresia, Estradiol

138 Effect of Heat Stress in Follicular Development of Dairy Cows in Intensive Production in North-Central Mexico. R.R. Lozano-Dominguez¹, C.F. Arechiga², and E. Gonzalez-Padilla*¹, ¹Universidad Nacional Autonoma de Mexico, Mexico, ²Universidad Autonoma de Zacatecas, Zacatecas, Mexico..

To assess the effect of heat stress in lactating dairy cows in intensive farming conditions, on ovarian follicular development, a study was carried out with 56 Holstein cows located in different farms in the state of Aguascalientes, Mexico. Daily ultrasound observations of both ovaries were performed between two estrous cycles. Average production of the herds was around 9500 kg per cow per year and studied cows were cycling regularly and had 71.2 ± 17.9 d in milk. Measurements were taken at four different times of the year according to temperature-humidity index 60 days prior or during the studied cycle. Therefore there were stressful (S) or neutral (N) conditions before or during evaluation: SN (n = 24), NN (n = 11), NS (n = 11) and SS (n = 10). The variables studied were: number of follicular waves per cycle (FW: 1, 2, and 3); maximum diameter of the dominant follicle (DF) in each wave (DDF, mm); growth rate of each DF (GRDF: 1 - first dominant follicle and 2 - second dominant follicle, mm/d); and growth length of each DF (GLDF, d). Data were analyzed by least square analysis of variance. Chi-square was utilized for analysis of proportions. In NN the DDF of FW1 was larger (20.9 ± 0.6 , $P < 0.05$) than in the other groups (SN, 19.1 ± 0.6 ; NS, 18.0 ± 0.8 ; SS, 18.6 ± 0.9). In FW2, the DDF of NS (16.9 ± 0.7) and SS (16.7 ± 0.8) were smaller ($P < 0.05$) than those of the SN (18.9 ± 0.6) and NN (19.2 ± 0.8). There were no differences in GRDF1 between groups ($P < 0.05$); however GRDF2 in SS (2.2 ± 0.3) was larger than in the other groups (SN, 1.4 ± 0.2 ; NN, 1.5 ± 0.3 ; NS, 1.3 ± 0.3) and had GLDF shorter (4.7d, $P < 0.05$) than SN (8.6d), NN (9.1d) or NS (7.1 d). Estrous cycles in SS group had more FW (2.6) ($P < 0.05$) than the rest. In SS + NS, in 36% of the cycles the ovulated follicle was of FW3 while this occurred in 9.1% of the cycles of NN+SN ($P < 0.05$). Thermal-humidity stress induces shorter periods of follicular growth and dominance and increases estrous cycles of three follicular waves, which may be related with lowered fertility in the warmer seasons of the year.

Key Words: follicular development, dairy cow, Mexico

139 Expression of insulin-like growth factor-binding protein-2, -3, -4, and -5 messenger RNA in fresh versus cultured bovine granulosa and theca cells. J.L. Voge*, D.T. Allen, J.R. Malayer, and L.J. Spicer, *Oklahoma State University.*

The objective of this study was to determine the presence of messenger RNA (mRNA) for IGF-binding protein (IGFBP)-2, -3, -4, and -5 in fresh versus cultured bovine granulosa and theca cells. Granulosa cells (GC) from small follicles (1-5 mm) and theca cells (TC) from large follicles (>7.9 mm) were collected from cattle and RNA isolated either before or after in vitro culture. For in vitro derived RNA, GC and TC were cultured for 2 d in medium with 10% fetal calf serum and an additional 2 d in serum-free medium. RNA from fresh and cultured cells was isolated using the Trizol extraction method. The presence of mRNA for IGFBP-2, -3, -4, and -5 was assessed using reverse transcriptase-PCR. IGFBP-2 mRNA was detected in 2 of 2 fresh and 4 of 5 cultured GC samples, and in 2 of 2 fresh and 4 of 6 cultured TC samples; the proportion of TC (85.7%) and GC (75%) samples that had detectable IGFBP-2 mRNA did not differ ($P > 0.50$, chi-square). IGFBP-3 mRNA was not detectable in either fresh or cultured GC, whereas IGFBP-3 mRNA was detectable in all fresh and cultured TC samples ($P < 0.005$). IGFBP-4 mRNA was expressed in 1 of 2 fresh GC samples and 3 of 5 cultured GC samples. IGFBP-4 mRNA expression was found in all fresh TC samples and in 4 of 6 cultured TC samples; the proportion of TC samples (87.5%) that had detectable IGFBP-4 mRNA tended to be greater ($P < 0.10$) than that of GC samples (42.9%). IGFBP-5 mRNA was detected in 1 of 2 of the fresh and 3 of 5 of the cultured GC. All of fresh TC and 4 of 6 cultured TC samples had IGFBP-5 mRNA; the proportion of TC (75%) and GC (57%) samples that had detectable IGFBP-5 mRNA did not differ ($P > 0.25$). These results indicate that IGFBP-3 may be produced by TC and not GC, whereas IGFBP-2, -4, and -5 are produced by both TC and GC. Furthermore, in vitro culture had no effect on whether or not IGFBP-2, -3, -4, and -5 mRNA was expressed in small GC or large TC.

Key Words: Insulin-like Growth Factors, Binding Proteins, Ovarian Follicles

140 Insulin plays a key role in re-coupling the IGF-somatotropin axis in the early postpartum dairy cow. S.T. Butler* and W.R. Butler, *Cornell University, Ithaca, NY.*

Negative energy balance associated with the onset of lactation results in hypoinsulinemia, uncoupling of the IGF-somatotropin axis, attenuation of gonadotropin release and delayed first ovulation. Our objectives were to examine the effects of elevated insulin during the immediate postpartum period on circulating IGF-I concentrations, ovarian follicular growth, estradiol secretion and LH pulse profiles. Holstein cows (n=14) were subjected to either a hyperinsulinemic-euglycemic clamp (INS) or saline infusion (CTL) for 96 hours starting on day 10 post-calving. Blood samples were taken on days 8-9 to establish baseline glucose values. Insulin was infused continuously (1 µg/kg BW/hr) via a jugular catheter. Blood samples were collected hourly, and euglycemia was maintained by infusion of exogenous glucose. During infusion, insulin concentrations were increased 8-fold in INS cows over those in CTL cows (2.4 ± 0.1 vs. 0.3 ± 0.1 ng/ml; P<0.001), while blood glucose concentrations were not different between the treatments (45.4 ± 2.2 vs. 41.7 ± 2.3 mg/dl; P=0.27). Plasma IGF-I increased continuously during the insulin infusion, and reached the highest values at the end of the clamp, being almost 4-fold higher in INS compared with CTL cows (122 ± 11 vs. 33 ± 2 ng/ml; P<0.001). Ultrasound measurements of ovarian follicular growth revealed that 2 cows ovulated, both of which were CTL cows. Among non-ovulatory cows, the dominant follicle reached a greater maximum diameter in the INS cows compared with CTL cows (13.4 ± 0.5 vs. 11.6 ± 0.6 mm; P=0.04). Excluding ovulatory cows, no difference in plasma estradiol was observed between groups during the infusion period (1.3 ± 0.2 vs. 1.1 ± 0.3 pg/ml; P=0.69). Blood samples collected every 10 minutes for 8 hours prior to and at the end of the infusion periods showed no differences between groups in LH pulse frequency, pulse amplitude or area under the curve. In conclusion, insulin appears to be a key metabolic signal in coupling the IGF-somatotropin axis, orchestrating the observed marked elevation in circulating IGF-I.

Key Words: Insulin, IGF-I, Ovary

141 Postpartum nutrition influences concentrations of leptin, IGF-I, and pregnancy rate of primiparous beef cows. N. H. Ciccio¹, R. P. Wettemann¹, L. J. Spicer¹, D. H. Keisler², C. A. Lents¹, and F. J. White¹, ¹Oklahoma Agricultural Experiment Station, Stillwater, ²University of Missouri-Columbia.

The influence of nutrition on plasma concentrations of leptin and IGF-I and reproductive function was determined at the first estrus in Hereford x Angus spring calving primiparous cows. At parturition, cows (BCS = 4.3 ± 0.1; BW = 385 ± 17 kg) were blocked by BCS and calving date and randomly assigned to gain 0.45 (M; n = 17) or 0.90 (H; n=17) kg/d for 11 wk. Then, all cows were fed the same (M) diet until the first estrus. A second replication was added to assess pregnancy rate (M; n = 13; H; n=17). Leptin and IGF-I were quantified weekly and progesterone thrice a week in blood plasma. Estrous behavior was detected with Heatwatch[®] and ovulation was determined using plasma progesterone. The dominant follicle was measured by ultrasonography at 4 to 14 h after onset of estrus. All cows were AI between 12 and 20 h after onset of estrus. During treatment, H cows gained (P < 0.01) BW

and BCS and had greater (P < 0.01) concentrations of leptin and IGF-I compared with M cows. From the end of treatment to first estrus, concentrations of IGF-I were greater (P < 0.01) in H cows; however, concentrations of leptin decreased (P < 0.01) in H cows after treatment termination and did not differ (P = .16) from those of M cows through the first estrus. Cows that exhibited estrus and ovulated on or before 19 wk postpartum had greater (P < 0.06) concentrations of leptin on wk 13 to 15 than anestrus cows. During treatment, leptin and IGF-I concentrations were positively correlated (P < 0.05) with changes in BW and BCS. H cows had a larger (P < 0.05) dominant follicle, more mounts (P < 0.06), and a shorter (P = 0.06) interval to estrus than M cows. Pregnancy rate at the first postpartum estrus was greater (P < 0.01) for H (n=34; 82.3 %) than for M (n=30; 60 %) cows. We conclude that increased nutrient intake after calving results in increased concentrations of IGF-I in plasma, and increased follicle size and pregnancy rate at the first estrus.

Key Words: IGF-I, Leptin, Reproduction

142 Concentrations of leptin and insulin like growth factor-I (IGF-I) during acute nutritionally induced anovulation and realimentation. F.J. White^{*1}, C.A. Lents¹, N.H. Ciccio¹, R.P. Wettemann¹, L.J. Spicer¹, and D.H. Keisler², ¹Oklahoma Agricultural Experiment Station, Stillwater, ²University of Missouri, Columbia.

Luteal activity and concentrations of leptin and IGF-I were evaluated during acute nutritional restriction and realimentation of beef heifers. Angus x Hereford heifers (14 mo old; n=19) were housed in individual pens and fed a diet supplying 1.2 x maintenance (M) for 1 wk. Then heifers were randomly allotted on d 0 to either 0.4 or 1.2 M. Heifers were treated with PGF2α on d -10, 0, and 10 to synchronize ovulation. After 30 d, 0.4 M heifers were gradually increased to 1.2 M during 10 d. Blood was collected 23 h after feeding on alternate days during restriction and 3 x per wk during 100 d realimentation. Heifers with progesterone <0.5 ng/mL for 8 d were classified as anovulatory. Seventy percent (7 of 10) of 0.4 M heifers did not ovulate on d 14 while all 1.2 M heifers had normal luteal function. Plasma IGF-I in 0.4 M heifers decreased from 49 ± 3 ng/mL on d 0 to 33 ± 4 ng/mL on d 14; however, 1.2 M heifers had similar concentrations on d 0 and 14 (57 ± 3; day x diet effect, P < .01). During restriction, heifers on 0.4 M tended (P = 0.1) to have decreased concentrations of leptin (14 % less) in serum compared with 1.2 M. Five of the anovulatory heifers had luteal activity by 16 to 51 d of realimentation at 1.2 M (mean = 35 d); however, two heifers did not ovulate by 100 d. Realimentation with 1.2 M for 2 wk increased concentrations of IGF-I in 0.4 M heifers (day x diet effect, P < 0.05) to concentrations similar to 1.2 M heifers. During realimentation, concentrations of leptin in blood samples taken after 23 h of fasting were similar (P > 0.1) in 0.4 and 1.2 M heifers. Concentrations of IGF-I in plasma decreased with acute nutritionally induced anovulation and were similar to those in control heifers (1.2 M) by 2 wk of realimentation at 1.2 M. Systemic concentrations of IGF-I were more indicative of nutritional status than concentrations of leptin in these acute nutritionally restricted heifers.

Key Words: Beef heifer, IGF-I, Leptin

ASAS/ADSA Ruminant Nutrition: Feed Additives

143 Influence of length and ramification of the alcohol radical of esters of methionine and of 2-hydroxy-4 (methylthio) butanoic acid on methionine bioavailability. J.C. Robert^{*1}, B.K. Sloan², G. Etave¹, and B. Bouza¹, ¹Aventis Animal Nutrition, Antony, France, ²Aventis Animal Nutrition, Alpharetta, USA.

In a series of five experiments, Methionine bioavailability from 8 DLmethionine and 3 HMB esters were tested according to the blood kinetics method based on determining the Area Under the Curve (AUC). The alcohol radical varied in number of carbons but all were arranged in a linear form. SmartamineTM M (a methionine coated with a pH sensitive polymer based coating) of which the methionine bioavailability is 80%, was used as a reference. Non lactating rumen cannulated Holstein cows, receiving 10 kg / animal / day of a ration comprising 75% hay and 25% concentrate delivered in equal quantities twice a day, were used. A single dose, 50 g of methionine equivalent, was supplied directly

into the rumen at 0800 on day two (D2) for the esters and at 1600 on day one (D1) for SmartamineTMM. Blood samples were obtained, on D2 at 0900,1000, 1100, 1300, 1500h and, thereafter, every three hours from 0900 to 1500h on D3 and D4. For SmartamineTMM, blood samples were collected every two hours on D2, starting at 0600 until 1000h and, thereafter, every three hours on D3 and D4 from 0600 until 1500h. Blood plasma methionine concentration (BPMC mg/100g) for base line determinations were measured on D1 at 0900,1100 and 1500h. Modelization of the AUC results for BPMC for the 11 esters resulted in the following relationship : Y = 40.6787 exp.(-0.2272 X)(R² = 0.89)(SED =6.13) Y = bioavailability as a percentage of methionine equivalent ingested. X = alcohol carbon number. It shows that methionine bioavailability decreases with increasing number of carbons in the alcohol. Three esters with branched alcohol radicals were tested vs. their corresponding linear forms using the same methodology described above. In all cases, methionine bioavailabilities with the corresponding branched alcohol were higher.

Products	Alcohol carbon numbers	Branching	Methionine bioavailability (%)
Methionine n-propyl ester	3	1	20.7
Methionine isopropyl ester	3	2	43.9
Methionine n-butyl ester	4	1	7.9
Methionine sec.-butyl ester	4	2	28
HMB n-butyl ester	4	1	17
HMB sec.-butyl ester	4	2	31

Key Words: Methionine, Bioavailability, Chemical derivatives

144 Investigation of the site of absorption and metabolism of a novel source of metabolisable methionine: 2 hydroxy 4 (methyl thio) butanoic acid isopropyl ester (HMBi). J.C. Robert*, C. Richard, T. D'Alfonso, N. Ballet, and E. Depres, *Aventis Animal Nutrition, Antony, France.*

In 2 tests, HMBi was delivered in a single dose, 50 g of methionine equivalent directly into the rumen. Two and four non lactating rumen cannulated Holstein cows were used in trials 1 and 2, respectively. They were offered 10 kg/cow/day of a ration comprising 75% hay and 25% concentrate delivered in 2 equal meals. Blood samples were obtained after supplementation at intervals of about 2h except in trial 2 where, during the interval 0-2h, more frequent blood samples were taken. Blood plasma HMB (BPHC) and blood plasma methionine concentrations (BPMC) were measured. In the two tests, a peak of HMB was observed (1h) followed by a methionine peak (4h) relative to ruminal delivery of HMBi. The appearance of HMB and methionine in plasma were found to be best described by a gamma function $Y = a + bX \exp(-cX)$ ($Y = \text{BPC}$ and $X = \text{hours post-supplementation}$). In trial 2, more frequent measurements during the 1st hour showed the virtually immediate appearance of HMB in peripheral blood after HMBi supply to the rumen. BPHC, zero before supplementation, rose quickly 1.41-1.73-2.05 mg/100g at times 10,20,30 min after supplementation. In parallel, BPMC increase from 0.35 to 0.45,0.66 and 0.83 mg/100g at the same times. This indicates HMBi is being absorbed through the rumen wall, subsequently dissociates to give HMB which is ultimately transaminated into methionine.

Assay	Meta-bo-lites	Intervals of time (h)	Peak hours	Max BPC (mg/100 g)	$y = a + bX \exp(-cX)$		
					Coefficients	R ²	SED
1	HMB	0 ≥ 10	1.3	1.48	a=0 b=3.13 c=0.7790	0.99	0.08
	Methio-nine	0 > 25	4.3	3.26	c=0.231	0.98	0.24
2	HMB	0 ≥ 24	1.3	2.64	c=0.7631	0.78	0.79
	Methio-nine	0 > 24	4.4	2.16	a=0.2850 b=1.1556 c=0.2267	0.93	0.22

Key Words: Methionine, Rumen absorption, Chemical derivative

145 Feeding 2-hydroxy-4-(methylthio)-butanoic acid to transition dairy cows improves milk production but not hepatic lipid metabolism. M. S. Piepenbrink*¹, A. L. Bork¹, M. R. Waldron¹, T. R. Overton¹, M. Vazquez-Anon², and M. D. Holt², ¹Cornell University, Ithaca, NY, ²Novus International, Inc., St. Louis, MO.

Forty-eight Holstein cows entering second or later lactation were utilized to determine the effects of 2-hydroxy-4-(methylthio)-butanoic acid

(HMB; Alimet[®] feed supplement, Novus International, Inc. St. Louis, MO) on milk production and hepatic lipid metabolism during the transition period. Cows were fed one of three diets as TMR starting 21 d before expected calving. These diets contained 0 (CON), 0.1 (+HMB), or 0.21 (++)HMB% HMB. From parturition to 84 DIM, cows were fed diets that contained 0, 0.15, or 0.23% HMB. The CON diets were formulated to be low in Met (1.98 and 1.77% of MP for pre- and postpartum diets) but adequate in Lys (7.23 and 7.00% of MP for pre- and postpartum diets). Prepartum (12.9, 12.8, 12.7 kg/d) and postpartum (18.6, 19.8, 19.7 kg/d) DMI were similar among cows fed CON, +HMB, and ++HMB ($P > 0.20$). Feeding +HMB increased milk yield (42.0, 45.0, and 42.0 kg/d for CON, +HMB, ++HMB; P (quadratic) < 0.05). Percentages of fat, protein, and total solids in milk were not affected by treatment. Trends ($P < 0.15$) for increased yields of 3.5% FCM, lactose, and total solids by cows fed +HMB were related to milk yield. Differences in plasma NEFA (495, 514, 446 $\mu\text{Eq/L}$) and β -hydroxybutyrate (13.72, 12.04, 11.92 mg/dl) were not significant ($P > 0.25$). Liver triglyceride content was similar on d 1 postpartum (7.24, 6.61, 6.75%) and was increased for +HMB on d 21 postpartum [(8.87, 13.68, 11.07%) treatment \times d; $P < 0.04$]. Differences in rates of [¹⁻¹⁴C]palmitate oxidation [27.9, 23.7, 25.4 nmoles/(hour \times g wet weight)], and formation into stored esterified products [318, 316, 338 nmoles/(hour \times g wet weight)] were not significant. The data suggest that adding HMB to low Met but adequate Lys diets at 0.1% prepartum and 0.15% postpartum is beneficial for increasing milk production. The underlying mechanism does not appear to be associated with hepatic lipid metabolism as measured in this experiment.

Key Words: HMB, Methionine, Liver

146 Use of milk protein concentrations to estimate the "methionine bioavailability" of two forms of 2-hydroxy-4-methylthio butanoic acid (HMB) for lactating cows. C. G. Schwab*¹, N. L. Whitehouse¹, A. M. McLaughlin¹, R. K. Kadariya¹, N. R. St-Pierre², B. K. Sloan³, R. M. Gill³, and J. C. Robert⁴, ¹University of New Hampshire, Durham, ²The Ohio State University, Columbus, ³Aventis Animal Nutrition, Alpharetta, GA, ⁴Aventis Animal Nutrition, Antony, France.

Forty multiparous Holstein cows (58 to 167 DIM) were assigned randomly to a balanced split-plot 5 \times 5 Latin square design involving two replicates of four squares. Experimental periods were 14 d with the last 7 d for measurements. Each square consisted of five concentrations of a single methionine (Met) source in a Met-deficient diet. The four Met sources were: 1) Smartamine M-TM (SmM, Aventis Animal Nutrition), 2) HMB, 3) the isopropyl ester of HMB (HMBi), and 4) a combination of HMB and HMBi (HMB/HMBi). Treatment levels were (g Met equivalents/d per 25 kg of DMI): SmM (0, 10, 15, 20, and 25), HMB and HMBi (0, 15, 20, 25, and 30), and HMB/HMBi (0/0, 5/10, 8.3/16.7, 11.7/23.3, and 15/30). Because treatment levels within source were not spaced equally, appropriate orthogonal coefficients were generated using PROC IML of SAS. Corrected LSM for milk protein percentages were: SmM (2.99, 3.08, 3.15, 3.15, and 3.13; quadratic effect, $P < 0.01$), HMB (3.04, 3.02, 3.03, 3.06, and 3.03), HMBi (3.05, 3.11, 3.16, 3.17, and 3.19; linear effect, $P < 0.001$), and HMB/HMBi (3.07, 3.13, 3.12, 3.16, and 3.18; linear effect, $P < 0.001$). Inspection of the LSM indicated that a broken line model of response to Met sources was more adequate than smooth function models. Thus, PROC NLIN of SAS was used to identify the optimum level of supplementation (breakpoint) and the slope of the dose-response relationships prior to breakpoint for SmM, HMBi, and HMB/HMBi. Based on differences of slope, and the assumption that 80% of the Met in SmM is available, the bioavailability of Met from HMBi and HMB/HMBi was estimated to be 42% and 34%, respectively. Results indicate that HMB provided little or no Met for milk protein synthesis and that HMBi was 50% or more as effective as SmM.

Key Words: Methionine, HMB, Ruminant

147 Performance of high producing dairy cows fed methionine hydroxy analog or D, L-methionine in a total mixed ration during early lactation. K. Uchida¹, P. Mandevu², C. J. Sniffen^{*2}, C. S. Ballard², and M. P. Carter², ¹Zen-Noh National Federation of Agricultural Co-operative Associations, Tokyo, Japan., ²W. H. Miner Agricultural Research Institute, Chazy, NY.

Effect of feeding two methionine supplements was compared using high producing Holstein cows during early lactation. Pregnant cows housed in a free-stall barn at the Miner Institute in northeastern New York, were blocked and at calving, were assigned randomly to one of two TMR containing a liquid form of methionine hydroxy analog (MHA; Novus Intl., Atlanta, GA), or D,L-methionine (D,L-Met), and group-fed for ad libitum intake. Cows spent 3315 days in the fresh group (FG), after which they were moved to the high producing group (HG) where they stayed up to 8 wk postpartum. The TMR had on DM basis a forage to concentrate ratio of 40 to 60% for FG cows with predicted DMI of 21.7 kg/d, and 42 to 58% for HG cows with predicted DMI of 26.5kg/d. All TMR contained on DM basis 33% NDF and 18% CP. The TMR were formulated using the CPM Dairy# model to meet the methionine and lysine factorial requirement, and the methionine and lysine ratios of 2.20 and 6.89% of metabolizable protein, respectively. The concentrations of methionine and lysine, respectively, in all TMR were 0.25, 0.75 (% of DM). In order to provide the same amount of methionine postruminally from the two methionine supplements, cows fed TMR containing MHA and D,L-Met, respectively, were fed approximately 14.2 g of MHA and 25.7 g of D,L-Met for FG and 17.1 g of MHA and 31.0 g of D,L-Met for HG, assuming a rumen escape value of 40% for MHA and 22% for D,L-Met. The average daily DMI by the group-fed cows across treatments was 22.5 kg/cow for the FG, and 27.2 kg/cow for HG. Cows that were fed TMR containing MHA and D,L-Met, respectively, had similar ($P>0.18$) milk yield (49.0, 49.8 kg/d; SE=0.32), milk fat (4.03, 4.21%; SE=0.051), milk CP (3.13, 3.21%; SE=0.019), linear SCC (4.08, 4.55; SE=0.072), body condition score (3.17, 3.17; SE=0.019), days to first service (68.7, 65.1; SE=6.61), and first service conception rate (36.9, 35.0%) during wk 1 to 8 postpartum, and different milk fat (3.64, 3.93%; SE=0.07, $P=0.07$) during wk 5 to 8 postpartum. Average milk yield was 45.5 kg during wk 1 to 4 postpartum and 53.3 kg during wk 5 to 8 postpartum. In conclusion, D,L-Met performed as well as MHA in promoting milk yield and contents of milk fat and CP when fed at levels aimed at achieving similar amounts of methionine postruminally as supplied by MHA.

Key Words: dairy cow, methionine hydroxy analog, milk yield and reproductive performance

148 Effect of two levels of crude protein and supplementation of methionine on performance of dairy cows. C. Leonardi^{*1}, L.E. Armentano¹, and M. Stevenson², ¹University of Wisconsin-Madison, ²Degussa Canada Ltd., Ontario, Canada.

Sixteen lactating Holstein cows (4 primiparous and 12 multiparous) were used in a 4 x 4 Latin Square, with periods of 35 days. At the beginning of the study animals averaged 95 DIM and produced 44.5 kg/d of milk. The effect of supplemental methionine at two levels of CP (16.1 vs. 18.8%) was tested. The two levels of protein and methionine supplementation were such that the lower level of CP supplemented methionine was sufficient to cover the requirements of amino acids, according to the Mepron Dairy Ration Evaluator ver. 2.1 (Degussa Huls Corp., Allendale NJ). The high level of protein (HP) was selected to meet the amino acids requirement without the supplementation of methionine. A low protein (LP) diet without methionine was added as negative control and the high protein diet plus methionine (HPM) as a positive control. All four diets contained 16.2% alfalfa silage, 38.6% corn silage, 16.2 % of corn grain, 8.1% soybean roasted, 5.7 % cottonseed, 2% soyplus, 1% blood meal, 0.8% animal fat, and 1.8 % minerals and vitamins mix (DM basis). The remaining 9.6% of the diet was either corn grain plus urea in the low protein diet, or soybean meal in the high protein diet. We anticipated an interaction where low protein responded to methionine more than the high protein diet, but no interactions were significant. The only methionine main effect was an increase in milk protein %, while increased dietary protein decreased milk protein %. Milk fat was depressed across diets. Low dietary NDF (27.2 % of DM), and high levels of vegetable oil (4.5 % fatty acids) may have been the cause of the low milk fat test. These dietary conditions may also have caused microbial protein synthesis to differ from the values predicted by the model used.

A main effect of dietary protein was to elevate milk fat concentration and yield.

	Treatments		Effect (P-value)					
	LP	LPM	HP	HPM	SEM	CP	Met	
DMI, kg/d	22.3	21.8	22.1	23.3	.8	.21	.49	
Milk yield, kg/d	42.7	41.0	42.2	42.8	1.6	.51	.63	
Protein, %	3.21	3.28	3.13	3.23	.08	.01	<.01	
Protein, g/d	1361	1330	1311	1373	45	.93	.71	
Fat, %	2.27	2.39	2.71	2.65	.12	<.01	.74	
Fat, g/d	949	958	1099	1116	59	<.01	.69	
MUN ¹ , mg/dl	10.44	10.60	14.53	14.17	.94	<.01	.88	
MUN, g/d	4.44	4.29	5.96	6.10	.5	<.01	.98	
Casein N/total N	.666	.641	.694	.691	.026	.13	.57	

¹MUN=milk urea nitrogen

Key Words: Crude protein, Methionine

149 Effects of rumen undegradable protein digestibility and supplemental methionine on production parameters and nitrogen efficiency of Holstein cows in early lactation. S. Noftsker* and N. St-Pierre, *The Ohio State University.*

A production trial followed by a collection trial was conducted to assess the effects of post-ruminal undegradable protein (RUP) digestibility, metabolizable protein supply and Met supplementation on production efficiency and N utilization of lactating dairy cows in early lactation. Treatments were: 1) 18.5 % crude protein (CP) with low estimated intestinal digestibility RUP (Control); 2) 18.5 % CP with high digestibility RUP (HiCP); 3) 17 % CP with high digestibility RUP (LowCP); and 4) 17 % CP with high digestibility RUP and supplemental Met (LowCP + Met). Thirty-six multiparous and 24 primiparous cows were assigned at random to one of the four dietary treatments 3 weeks post-freshening. At week 13, six cows from each treatment were placed in metabolic stalls for a digestibility study, each cow remaining on the same treatment as during the production trial. Treatments had a significant effect on dry matter intake (21.7, 23.3, 23.2, 23.6; SE = .05 kg/d), milk production (40.8, 46.2, 42.9, 46.6; SE = 0.7 kg/d), protein production (1.20, 1.38, 1.28, 1.44; SE = 0.02 kg/d) and milk protein content (2.95, 2.99, 3.00, 3.09; SE = 0.03 %) for Control, HiCP, LowCP, and LowCP + Met respectively in the production trial. Nitrogen balance results are reported in the following table. Lowering the CP in diets in early lactation in conjunction with selection of RUP sources selected for higher estimated post-ruminal RUP digestibility can improve the efficiency of N utilization. The supplementation of Met did not improve the efficiency of N utilization during the digestibility study, in contrast to what was estimated during the production trial.

	LowCP				SEM	p-value
	Control	HiCP	LowCP	+ Met		
N intake (g/d)	759	734	681	679	27.9	.031
N feces (g/d)	279	271	257	263	10.9	.292
N urine (g/d)	268	259	215	224	19.3	.067
N milk (g/d)	223	217	223	216	9.4	.909
N retained (g/d)	-0.6	-13.2	-15.6	-23.3	18.3	.838
App. N						
digestibility (%)	63.7	62.9	61.9	60.8	1.8	.320
N excreted/N milk	2.44 ^a	2.44 ^a	2.09 ^b	2.24 ^{ab}	.092	.039

Key Words: RUP digestibility, methionine, N efficiency

150 Ruminal escape and response of serum methionine to 25 and 50 grams of methionine hydroxy analog in dairy cows. K. M. Koenig^{*1}, M. Vazquez-Anon², C. D. Knight², and L. M. Rode¹, ¹Agriculture and Agri-Food Canada, Research Centre, Lethbridge, AB, Canada, ²Novus International, Inc., St. Louis, MO, US.

Ruminal escape of various amounts of methionine hydroxy analog [D,L-2-hydroxy-4-(methylthio)-butanoic acid (HMB), Novus International Inc., St. Louis, MO] was measured in an experiment designed as a 4 x 4 Latin square using four lactating dairy cows with cannula in the rumen. The cows were fed a diet composed of corn silage, alfalfa haylage, rolled barley grain, canola meal, and blood meal, three times per day. The cows were fed the liquid analog each day for one week prior to the initiation of the experiment. On the day of the experiment, each

cow received an oral bolus dose of 0, 25, or 50 g of the liquid analog (Alimet[®] feed supplement, 88% HMB) or 51.2 g of a dry calcium salt of the analog (86% HMB; MHA[®]) mixed with 0.5 kg of ground barley grain. After a period of 30 min, any remains of the carrier grain and treatment were placed in the rumen. A liquid phase marker (Co-EDTA) was administered as a bolus dose into the rumen at the time of oral administration of the methionine analogs. Rumen contents and blood serum were collected at 0, 1, 3, 6, 9, 12 and 24 h relative to the time of dosing. Rumen samples were analyzed for Co and HMB, and serum was analyzed for free methionine. Fractional rate constants for the passage of the liquid marker (k_p) and the decline of HMB concentration in the rumen (k_{rHMB}) were determined by non-linear regression. Liquid passage from the rumen was similar among the four analog treatments (0.136 ± 0.022 /h; mean \pm SEM). Ruminal escape of HMB as a percentage of the dose ($100\% \times k_p/k_{rHMB}$) did not differ between cows receiving 25, 50, and 51.2 g of the methionine analogs (42.5, 41.0, and $34.9 \pm 9.0\%$, respectively) and averaged 39.5%. Serum methionine concentration peaked at 3 and 6 h after dosing and increased in proportion to the amount of the analog administered. It was concluded that 39% of the methionine hydroxy analog escaped rumen degradation, the percentage of the dose that escaped the rumen was not affected by the amount or form of the methionine analog fed, and the analog that escaped ruminal degradation was absorbed and metabolized to methionine.

Key Words: HMB, Methionine, Ruminal escape

151 Carbohydrate fermentation and nitrogen metabolism of a finishing diet by ruminal microbes in continuous cultures as affected by ethoxyquin and (or) supplementation of monensin and tylosin. H. Han^{*1}, H. S. Hussein¹, H. A. Glimp¹, D. H. Saylor², and L. W. Greene³, ¹University of Nevada - Reno, ²Solutia Inc., ³Texas A&M University.

Long-term feedlot studies have shown positive effects (i.e., improved ADG and gain/feed; reduced morbidity and mortality) of dietary supplementation with ethoxyquin (AGRADO[®]). This may be due to improving the antioxidant capacity at the ruminal, post-ruminal, or post-absorption levels. This study was designed to investigate the potential antioxidant role of ethoxyquin at the rumen level. A finishing diet (12.5% CP; DM basis) was formulated to contain (on a DM basis) 77.5% flaked corn, 10% corn cobs, 10% protein/vitamin/mineral supplement, and 2.5% animal fat. In a randomized complete block design experiment, the treatments were arranged as a 2×2 factorial. The main factors were 2 ethoxyquin treatments (without or with 150 ppm) and 2 monensin/tylosin treatments (without or with monensin and tylosin at .0028 and .0014% of dietary DM, respectively). Eight dual-flow continuous culture fermenters were used in two experimental periods (blocks; 8 d each with 5 d for adjustment and 3 d for sample collection) to allow for 4 replications for each treatment. No interactions ($P > .05$) were detected for any of the measurements evaluated. Therefore, results of the main factors were summarized. Ethoxyquin supplementation improved ($P < .05$) true digestibility of DM (from 40.7 to 47.1%) and OM (from 38.8 to 45.0%) but it did not alter ($P > .05$) concentrations of total VFA (averaging 131.4 mM) or acetate (averaging 58.8 mM). Ethoxyquin decreased ($P < .05$) propionate concentration from 51.1 to 42.4 mM and increased ($P < .05$) butyrate concentration from 18.4 to 22.9 mM. Digestion of total nonstructural carbohydrates was not altered ($P > .05$) by the treatments and averaged 86%. With the exception of increased ($P < .05$) concentration of propionate (from 42.0 to 51.5 mM) and decreased ($P < .05$) concentration of butyrate (from 25.9 to 16.3 mM), no effects were detected for monensin/tylosin. Ruminal N metabolism including efficiency of bacterial protein synthesis (averaging 21.2 g N/kg OM truly digested) was not affected ($P > .05$) by the treatments. Results suggest positive effects of ethoxyquin on ruminal digestion of DM and OM and unique changes in VFA production.

Key Words: Continuous culture, Ethoxyquin, Beef cattle

152 Comparison of different methods of administration on the effect of fibrolytic enzymes on digestive processes in lactating cows. J.D. Sutton^{*1}, R.H. Phipps¹, D.E. Beever¹, D.J. Humphries¹, G.F. Hartnell², and J.L. Vicini², ¹University of Reading, UK, ²Monsanto Co, St Louis, MO.

To clarify the site of action of fibrolytic enzymes extracted from *Trichoderma longibrachiatum*, four multiparous Holstein x Friesian cows with cannulas in the rumen and proximal duodenum were used in a 4 x

4 Latin square experiment with 5-wk periods. From lactation wk 5, the cows were given ad libitum a TMR composed of (DM) 57% forage (3:1 maize silage:grass silage) and 43% concentrates. The TMR contained (g/kg DM): 274 NDF, 295 starch, 180 CP. Treatments were TMR alone (T1) or TMR with the enzymes added (2 g/kg TMR DM) either sprayed on the TMR 1 h before the morning feed (T2), sprayed only on the concentrate the day before feeding (T3), or infused into the rumen for 14 h/d (T4). Xylanase and endoglucanase activities of the enzymes were 26,483 and 2,645 mol.min⁻¹.g⁻¹. There was no significant effect on feed intake (T1-T4: 20.7, 21.1, 20.9, 20.4 kg DM/d, s.e.m. 0.43) or milk yield (34.0, 35.5, 34.5, 35.0 kg/d, s.e.m. 0.52) but both were highest on T2. Rumen digestibility of DM (0.321) and starch (0.843) was unaffected. Digestibility of NDF was lowest on T2 in the rumen (0.449, 0.335, 0.402, 0.492, $P < 0.05$) but highest on T2 post-ruminally (0.090, 0.247, 0.161, 0.006, $P < 0.05$). Total tract digestibility was highest on T2 for DM (0.714, 0.724, 0.707, 0.714, $P < 0.05$) and starch (0.970, 0.977, 0.970, 0.972, $P < 0.05$) but treatment differences were non-significant for NDF (0.503). Maize silage stover passage rate out of the rumen was increased by all enzyme treatments (0.025, 0.030, 0.033, 0.032 h⁻¹, $P < 0.05$) but gut transit time was also increased (12.5, 16.7, 16.1, 15.9 h, $P < 0.05$) so the decline in total tract retention time (61.2, 58.3, 54.5, 55.7 h, s.e.m. 2.57) was not significant. Although inclusion of these enzymes by all three methods altered digesta kinetics, it was only when they were sprayed on the TMR that diet utilisation was improved with higher DM digestibility and a numerical increase in milk yield.

Key Words: Enzymes, Dairy Cows, Forage

153 Effects of liquid feed supplementation and (or) cellulolytic enzymes on dry matter disappearance of either legume or grass hay. G. V. Pollard^{*1}, W. T. Wright¹, T. C. Bramble¹, C. R. Richardson¹, and C. W. Cobb², ¹Texas Tech University, Lubbock, ²Loveland Ind., Inc., Greeley, CO.

The objective of this research was to determine if pH of a suspension liquid feed product and (or) cellulolytic enzyme supplementation increases the digestibility of forage as indicated by in vitro dry matter disappearance (IVDMD). Liquid feed suspensions (32% CP, as fed) and cellulolytic enzymes (CE) were added as aqueous solutions and sprayed directly onto ground (1mm) .5 g samples of alfalfa, wheat, or grass hay. Treatments were negative control (CON); enzyme only (ENZ); liquid supplement, pH 4 (LS); liquid supplement plus enzyme (LE); liquid supplement plus enzyme buffered to pH 5 (LE5). Levels of CE were equivalent to 185 g per 907 kg of forage DM and liquid feed supplement levels were equivalent to intakes of 1 kg as fed/hd/d. The IVDMD of samples was determined following a 24 h incubation in 100-mL in vitro tubes containing 50-mL of a buffer and rumen fluid mixture. Rumen fluid was obtained from a cannulated steer fed a roughage diet. Alfalfa hay samples had greater ($P < .05$) overall IVDMD than either wheat or grass hay samples. Alfalfa hay IVDMD was improved ($P < .05$) by ENZ, LS, and LE, however, alfalfa hay was unaffected ($P > .05$) by LE5. Wheat hay samples were unaffected ($P > .05$) by dietary treatments, however LE5 tended ($P = .09$) to improve IVDMD over CON. Also, ENZ tended ($P = .08$) to have lower IVDMD when compared to LS in wheat hay, and reduced ($P < .05$) IVDMD in alfalfa hay. In contrast, grass hay samples were unaffected ($P > .05$) by either LS or ENZ, while both LE and LE5 improved ($P < .05$) IVDMD. Treatments containing liquid feed supplements and (or) CE resulted in greater overall IVDMD in both alfalfa and grass hay samples. These results indicate that the addition of CE and liquid feed supplements either separately or in combination, improves digestibility of alfalfa and grass forage. However, buffering liquid feed supplements containing CE from pH 4 to pH 5 appears to be unwarranted.

Key Words: Enzymes, Liquid feed, Dry matter disappearance

154 Effects of ruminant feed enzyme additives on digestibility evaluated in vitro. G. R. Bowman^{*1}, K. A. Beauchemin², and J. A. Shelford¹, ¹University of British Columbia, Vancouver, Canada, ²Agriculture and Agri-Food Canada, Lethbridge, Canada.

A study was conducted to determine if fibrolytic enzymes increase feed digestion by ruminants. A revolving digestion incubator and mesh bags (9.5 X 19.5 cm) were used to evaluate the dry matter digestibility (DMD,%) and neutral detergent fiber digestibility (NDFD,%) of a TMR for dairy cows consisting of barley silage and barley grain or the same

TMR treated with a fibrolytic enzyme product (Promote, Agribands Intern., St. Louis, MO). The objectives were: 1) determine whether enzymes improve DMD or NDFD, and 2) establish whether increased digestibility was due to feed-treatment effect or an enhancement of the hydrolytic capacity of the ruminal fluid. Two cannulated lactating Holstein cows were fed a sequence of four TMR: no enzymes (-E), enzymes added to the concentrate portion of the TMR (C+E), enzymes added to the supplement portion of the TMR (S+E), or enzymes added to the premix portion of the TMR (P+E). The same cows served as rumen fluid donors, which was composited by diet. Fresh, unground TMR was incubated in vitro for 12 or 48 h. At 12 h, when rumen fluid from the respective diets was used, -E showed the lowest DMD (41.2^a), followed by S+E (43.2^{ab}), C+E (44.7^b), and P+E (44.8^b). However, there were no differences ($P > 0.05$) among treatments for NDFD at 12 h (20.08±12.0). There was no effect of treatment ($P > 0.05$) at 48 h for DMD (59.83±3.8) or NDFD (40.88±9.3). When the -E TMR was incubated with the various inoculates, there was no improvement in its DMD or NDFD at 12 or 48 h. We did not test the effects of incubating the enzyme-treated TMR in ruminal fluid from cows fed -E. This study indicates that fibrolytic enzymes increase DMD during the early stages of digestion. However, enzyme supplementation has no effect on feed digestibility at longer incubation times, which may indicate that enzymes improve rate, rather than extent, of digestion. Enzymes must be in physical contact with the feed to improve digestibility.

Key Words: Enzyme, Digestibility, in vitro

155 The effect of different levels of yeast culture inclusion in the concentrate diet on calf performance. R.J. Fallon*¹ and B. Earley¹, ¹Teagasc.

The recent banning of a number of in-feed antibiotic digestive enhancers within the European Union has generated the need to find suitable non-antibiotic alternatives. Yeast culture (YeaSacc 1026) as a supplement has been evaluated in several growth studies in calves, steers and bulls. There is however, little information available on the optimum level of YeaSacc 1026 for inclusion in the calf concentrate ration. The aim of this study was to determine the optimum level of YeaSacc 1026 inclusion. The following experiment was undertaken using 80 Friesian male calves (average initial weight of 54 kg) to determine the optimum inclusion rate of YeaSacc 1026 in a barley soyabean meal ration. Calves were allocated at random to 1 of 4 treatments: 1) 0, 2) 0.625, 3) 1.25 and 4) 2.5 kg YeaSacc 1026 per tonne of ration. The concentrate ration was available ad libitum throughout the 84 day experimental period and the calves were offered 25 kg of calf milk replacer by bucket over the initial 42 day period. Calf liveweight gain in the period 1-42 days was 0.58, 0.65, 0.65 and 0.68 (s.e.d 0.029) kg/d for treatments 1 through 4, respectively. The corresponding liveweight gain for the period 1 to 84 days were 0.84, 0.92, 0.92 and 0.89 (s.e.d 0.026) kg/day, respectively. Concentrate intake (1 to 42 day) were 25, 29, 30 and 31 (s.e.d 2.1) kg, respectively the corresponding values for the period 43 to 84 days was 129, 138, 138 and 140 kg. It was concluded that the inclusion of 0.625 or 1.25 kg of YeaSacc 1026 per tonne of ration increased calf liveweight gain by 5 kg in the period 1 to 84 days.

Key Words: Yeast Culture, YeaSacc, Calves

156 The effect of different levels of YeaSacc 1026 inclusion on the lifetime performance of cattle offered an ad libitum concentrate ration. R.J. Fallon*¹ and B. Earley¹, ¹Teagasc.

The recent banning of a number of in feed antibiotic digestive enhancers within the European Union has generated the need to find suitable non-antibiotic alternatives. Yeast culture (YeaSacc 1026) as a supplement

has been evaluated in several growth studies in calves, steers and bulls. There is however, little information available on the optimum level of YeaSacc 1026 for inclusion in the diet on the lifetime performance of bulls offered an ad libitum concentrate diet. The aim of this study was to determine the optimum level of YeaSacc 1026 inclusion. The following experiment was undertaken using 80 Friesian male calves (average initial weight of 54 kg) to determine the optimum inclusion rate of YeaSacc 1026. Calves were allocated at random to 1 of 4 treatments: 1) 0, 2) 0.625, 3) 1.25 and 4) 2.5 kg YeaSacc per tonne of ration using individual bulls as the experimental unit. The concentrate ration consisted of rolled barley, soya bean meal plus minerals and vitamins was available throughout the 329 day experimental period. The crude protein content was 168 g/kg to 12 weeks and 151 g/kg there after. In addition the animals were offered a fixed daily allowance of straw (80g/kg of concentrates). Bull liveweight gain in the period 1 to 168 days was 1.11, 1.14, 1.20 and 1.15 (s.e.d 0.022) kg/day from treatments 1 through 4, respectively. The corresponding liveweight gains for the period 169 to 329 days were 1.32, 1.36, 1.34 and 1.36 (s.e.d 0.043) respectively. The corresponding concentrate dry matter intakes were 548, 562, 583 and 565 for the period 1 to 168 days and 1122, 1161, 1208, 1143 for the period 169 to 329 days. The corresponding carcass weights were 233, 239, 242 and 239 kg. It was concluded that the 1.25 kg/tonne inclusion rate for YeaSacc 1026 resulted in a response in the 1 to 168 day period, but was not significant

Key Words: Yeast Culture, Cattle, Dose Response

157 The effects of feeding a fungal extract (Amaferm) to ewes 60 days prepartum through weaning on milk protein, fat, lactose and yield. S. L. Campbell*, S. P. Jackson, A. D. Herring, M. L. Galyean, and D. R. Niemann, Texas Tech University Lubbock, TX/US.

The objectives of this study were to determine differences in milk protein, fat, lactose and milk yield in ewes either fed whole corn and CSM (control) or the same diet plus Amaferm (AMF), which contains the fungal extract *Aspergillus oryzae*. Sixty-two Rambouillet ewes from ages 3 to 7 yr. were randomly assigned to four pens, and treatments were randomly assigned to each pen. Milk protein, fat, and lactose were measured in milk samples taken at parturition (time 0), 6 h and every 12 h thereafter for the first 36 h and additionally at 3 wk and 6 wk. Milk yield was measured at 3 and 6wk postpartum. Milk yield was not affected by treatment at the 3 or 6 wk milking time. Milk protein decreased linearly through lactation. Percent milk protein was 11.63, 10.99, 9.19, 7.06, 6.38, 5.12, and 5.12 at time 0, 6 h, 12 h, 24 h, 36 h, 3 wk, and 6 wk, respectively. Percent milk fat increased from 8.50 at time 0 to 9.69 at 6 h, then decreased to 8.75 by 36 h., and 5.06 at 3 wk., but increased to 5.34 by 6 wk postpartum. Percent milk lactose increased linearly through lactation (3.28, 3.54, 3.90, 4.33, 4.46, 5.37, and 5.31 at time 0, 6h, 12 h, 24 h, 36 h, 3 wk, and 6 wk, respectively). There were no differences in milk protein between ewes fed AMF or the control diet over the entire lactation, but there was a trend at 6 h, suggesting the control group had a slightly higher milk protein content ($P = .06$) than the AMF group. Ewes on AMF had higher milk fat than ewes on the control diet at 0 h. ($P = .004$) and 3 wk ($P = .02$) and tended to have higher milk fat at 6 h ($P = .10$). Milk lactose was lower in ewes consuming AMF at 6 h. ($P = .02$) and tended to be lower at 12 h ($P = .08$) than for ewes in the control group. In this study, Amaferm addition to the diet did not affect milk yield, but it increased milk fat and decreased milk lactose at certain stages of lactation.

Key Words: Amaferm, Sheep, Lactation

PSA Environment and Management: Broilers

158 Impact of Aflatoxin in the feed on Coccidial infection in broiler chicks. V.G. Stanley¹, D. Spiller*¹, W. Kruger², and A. Sefton³, ¹Prairie view A&M University, ²Texas A&M University, ³Alltech, Guelph Canada.

An experiment was conducted to examine the effects of aflatoxin on male broiler chicks infected with *Eimeria acervulina*. The experimental design was a 2 x 2 factorial, consisting of two levels of aflatoxin (0; 3 mg/kg) and two levels of coccidia (0; 500,000 oocysts/chick). Chicks

were fed an aflatoxin-treated or non-aflatoxin-treated diet (control) from 1 d of age through 28 d of age. At 14 d of age, the chicks were infected with *Eimeria acervulina*. At 14 d post-infection the effects of treatments were assessed on weight gains, relative organs (liver, pancreas, gizzard, proventriculus, heart and cecal) weights, and gross lesion scores. Blood was collected for serum chemistry values, and enzyme activities. Weight gain in chicks fed the aflatoxin-treated diet infected with *E. acervulina* was significantly lower ($P < .05$) than the control by 26.8 percent. Chicks fed an aflatoxin-treated diet had a 20.46 percent

reduction in weight gain, whereas those infected with the coccidia only had 19.12 percent reduction in weight gain. Combined effects of aflatoxin and coccidiosis significantly increased the relative weight of the liver, gizzard, and the serum concentration of triglycerides. The toxicity of aflatoxin and coccidiosis was expressed mainly through decreased serum concentration of uric acid, albumin, total protein, cholesterol and the activity of alanine aminotransferase. Significant increase in relative cecal weight was seen in both aflatoxin and coccidiosis treatments. Intestinal lesion scores were observed in both groups, but were more severe in the chicks fed aflatoxin and later infected with coccidia. It was concluded that coccidial infection was intensified by the presence of aflatoxin in the feed.

Key Words: Chicks, Aflatoxin, Coccidiosis

159 The impact of methionine source on poultry fecal matter odor volatiles. C. Chavez*¹, T. P. Niemeyer¹, P. L. Reynolds¹, R. A. Russo¹, R. E. Lacey², and J. B. Carey¹, ¹Department of Poultry Science, Texas A&M University, College Station, TX, ²Department of Agricultural Engineering, Texas A&M University, College Station, TX.

Trials were conducted using straight run broiler chicks raised in battery cages. Chicks were randomly distributed into 3 replications of 4 treatment groups with 16 birds per pen. The treatment groups were dry methionine hydroxy analogue (52% methionine activity), sodium methionine aqueous solution (45.9% methionine activity), liquid methionine hydroxy analogue (89% methionine activity), and no supplemental methionine (control group). All diets were formulated to contain 3,135 Kcal ME/kg, 23% crude protein, 0.8% total methionine activity and otherwise met NRC nutrient requirements. Diets were fed *ad libitum* from day 1 to termination of the study (5-6 weeks). Feed consumption and feed conversion were measured daily and all birds were weighed weekly. There were no significant differences in body weight, feed consumption, and feed conversion among the treatments in any trials. All excreta was collected in litter pans lined with aluminum foil. Weekly, litter pans for each pen were individually transferred to a separate room for odor volatile analysis. A Cyranose 320[®] (Cyranose Sciences, Inc., Pasadena, CA) electronic nose was used to capture 3 to 4 air samples from various locations for each pan of broiler excreta resulting in a total of 10 air samples from each treatment group. All data taken from the Cyranose 320 were evaluated using principal component analysis and indicated that there were significant differences in volatiles in the broiler excreta for all treatment groups. These data indicate that different methionine sources may result in the production of different odor related compounds in broiler excreta.

Key Words: Methionine, Broiler excreta, Odor

160 Impact of Farm Management Practices on the Microbial Profile of Processed Broilers. Marcos Sánchez*¹, Wade Fluckey, Mindy Brashears, Eva Wallner-Pendleton, Marcela Tamayo, Adriana Aguilar, and Shelly Mckee, ¹University of Nebraska-Lincoln, Lincoln, NE.

Bacterial loads on birds coming into the processing plant impact the presence of pathogens on processed broilers. Conditions during growout including farm management practices, water source and environmental parameters were investigated. Four farms were tested every 3 months over a 1 year period. Farms were evaluated based on survey data and microbial testing. Farm surveys examined building and age condition, litter management, house ventilation, routine sanitation between flocks, biosecurity measures, bird density, bird strain, vaccination history, incidence of disease and mortality, growing season temperatures, water source and water system conditions. In addition, airflow readings, ammonia levels, water activity, relative humidity and house temperature were determined for each house tested. Drag swab (DS) samples of litter and ceca samples from birds were aseptically obtained to determine levels of pre-harvest contamination with pathogens. Sampling locations were determined by differentiating between wet and dry areas of the litter based on water activity readings. DS and ceca samples were tested for *Salmonella*, *Campylobacter*, aerobic populations, coliforms and generic *E. coli*. Results suggested that water activity in the litter, airflow in the poultry house and water source appeared critical to controlling microbial levels on the farm. Open pond water as a drinking source for birds was correlated to higher levels of *Salmonella* and *Campylobacter* on the farm and in the processing plant. DS and ceca

samples obtained in areas of high Aw on the farm had higher bacterial populations and a higher incidence of pathogens. High numbers of pathogens on farms were equated to a higher incidence of *Salmonella* and *Campylobacter* on broilers when sampled during processing. These data suggest that improving environmental conditions and management practices may enhance the safety of birds supplied to the processing facility.

Key Words: Poultry farm management, *Salmonella*, *Campylobacter*

161 Estimation of the growth potential of six commercial strains of broiler chickens. M. J. Zuidhof*¹, D. Eisenbart¹, Z. Wang¹, and G. Hinse², ¹Alberta Agriculture, Food and Rural Development, ²University of Alberta.

In order to model the growth of any animal, there must be an appropriate description of the type of animal being grown. A study was conducted to determine the growth potential of six strains of commercial broiler chickens. Gompertz growth parameters were determined for males and females of each strain. An assumption of the Gompertz model is that the birds must be able to achieve their genetic potential for growth. Therefore utmost care was taken to ensure that ideal environments were provided. Careful attention was spent to ensure appropriate temperatures, pen hygiene, nutrition, and other potential environmental constraints to growth were eliminated. A total of 984 (82 males and 82 females) of six strains of broilers were placed at 0 d of age and reared to 16 wk. Every week from 0 to 8 wk, and every second week thereafter, two birds closest to the mean body weight of each strain by sex combination were dissected and carcass composition was determined on the plucked empty (feed removed from gut) carcasses by chemical analysis. Gompertz parameters are reported as asymptotic weights (Wmax) and rates of maturing (b) expressed in the units g and d⁻¹, respectively. Body weight asymptotes ranged from 2679 to 2950 for the females (b = 0.0461 and 0.0427, respectively) for females, and from 3385 to 3811 (b = 0.0417 and 0.0396, respectively) for males. Protein asymptotes ranged from 341 to 393 g in females and 466 to 514 in males (b = 0.0493, 0.0396, 0.0446 and 0.0423, respectively). Fat asymptotes ranged from 17.7 to 21.7% of the mature weight asymptotes in females, and from 13.9 to 16.2% in males.

Key Words: Gompertz, Growth model, Broiler strains

162 Temperature gradients in trailers transporting broilers under Canadian winter conditions. T.D. Knezacek*, G.P. Audren, H.L. Classen, E.M. Barber, T.G. Crowe, and S. Stephens, University of Saskatchewan, Saskatoon, SK, Canada.

Five commercial scale broiler transport trailers, using Anglia Autoflow modules, were monitored under Canadian winter conditions to investigate the development of horizontal and vertical temperature gradients during transportation. Five evenly distributed stacks of modules were each equipped with nine data loggers recording the temperature and relative humidity of the microenvironment at one-minute intervals. In one stack of modules, loggers were placed in each of the top, middle and bottom rows of crates to determine the vertical temperature gradients. Horizontal temperature gradients were recorded in each of these rows by placing loggers in the center of the middle crate and at the extreme edges of the outside crates. Temperature heterogeneity was found among modules in all loads with average temperatures ranging from -2 to 18, -4 to 19, -4 to 18, -4 to 21, and -2 to 26 C for journey lengths of 155, 171, 152, 184, and 229 minutes and ambient temperatures of -7, -11, -13, -10, and -9 C, respectively. Temperatures within the modules increased 5-35 C above ambient recordings due to low levels of passive ventilation on the tightly tarped trailers. Loggers along the rear outside edges of the trailer recorded temperatures closest to ambient conditions, indicating that air entered in this area. Horizontal temperature gradients, from tarp to tarp, and vertical temperature gradients between the roof and floor of the trailer were generated. However, the degree of variation was dependent upon the ventilation configuration, which was altered according to ambient temperature. In conclusion, the results suggest that passively ventilated transport trailers expose broilers to less than optimum microenvironments, with the greatest imposition occurring along the rear outside edges of the trailer.

Key Words: Broiler, Transportation, Temperature Gradients

163 Effect of cyclic heat stress on voluntary water consumption, Efficiency of feed utilization and thyroid activity of broiler chicks. Miriam ELDeeb*¹ and A. Abou-Elmagd², ¹College of Agriculture, ²College of Vet. Medicine.

The effect of cyclic heat stress temperature (24-35-24°C) on voluntary water consumption and efficiency of feed utilization as well as microscopic structure of thyroid gland were studied in broiler chicks growing on litter from hatch till 6 wk-old. Results indicated that heat stress chicks markedly increased ($P \leq .01$) voluntary water consumption (ml/kg BW^{0.75}) over the control during growing period (3-6 wk-old). Water:feed ratio indicated higher ($P \leq .01$) ratio for birds subjected to 7h. daily heat stress 35°C at both periods; 3 and 6 wk-old. Body weight of chicks subjected to heat stress was significantly ($P \leq .01$) lowered by about 24.6% at 6 wk-old. Consequently, overall reduction in body gain during exposure to heat stress was about 25.2%. The depression in body gain of broiler were 5 and 42g/ bird/ 1°C from 24-35°C at 3 and 6 wk-old, respectively. Also, feed consumption were reduced in heat stress birds by about 10.3 and 48.5g/ bird/ 1°C above the control at 3 and 6 wk-old, respectively. Hence, feed conversion ratio was significantly ($P \leq .01$) decreased clearly at 6 wk-old. The percentage of abdominal fat was significantly ($P \leq .05$) reduced in birds subjected to heat stress. Neither, RBC count nor Hb was affected by heat stress. Furthermore, total moisture and expressible fluids in breast muscles; pectoralis major and minor were not influenced by heat stress treatment. Microscopic examination and morphometric measurements revealed remarkable decrease in the thyroid activity after 6 week exposure to the heat stress compared with the control group. The reduction in thyroid activity was represented by significant increase in the area percentage of follicular colloid in treated group (24.1±3.07) than that in control group (6.9±3.35), and decreased in follicular epithelium percentage in treated group (36.5±5.46) compared with control group (68.6±7.15). Additionally, the area percentage of the large follicles significantly increased ($P \leq .01$) as well as the area percentage of small follicles significantly decreased ($P \leq .01$) at end of the experiment in comparison with that in the control group. In conclusion, heat stress exposure resulted in lower activity of the thyroid gland that may be responsible for lower performance of broiler chicks.

Key Words: broiler chicks, heat stress, thyroid activity

164 Sources of Salmonellae in typical Delmarva broiler operations. J. deGraft-Hanson*, E. LaBreque, A. Dorsey, A. Evangelista, R. Porreca, and L. Baker, *University of Maryland, Princess Anne, Md. USA.*

Two typical broiler houses on Delmarva were sampled every two weeks beginning at placement and continuing to processing. The objective was to determine animate and inanimate sources of salmonellae in the grow-out system. Samples collected included feed, litter, drag swabs, drinking and outside standing water, beetles, flies, flying insects, boot swabs, feces from chickens, animals, wild birds and chick pads. All samples were pre-enriched in BPW, selectively enriched in TTH and RV broths, isolated on XLT4, MLIA and BGSA, screened biochemically on TSI and serogrouped for confirmation. When chick pads were positive there was a tendency for the flocks to be positive throughout the life cycle as evidenced by positive litter, drag swabs and chicken feces. Beetles and flies were also positive on occasion. Outside samples that were positive were water, mud, animal and bird feces. Of an average number of 70 samples per visit positive samples ranged from 0 to 88%. When chick pads were negative, flocks usually had low levels of salmonellae. The higher the number of positive chicken feces the more the positive samples taken inside the houses. Negative inside samples at placement indicated effective cleaning of houses between flocks. In the processing plant, crates and carcasses were positive with carcasses ranging from 0 to 96%. Both pre and post chill water were usually negative.

Key Words: Broiler houses, Processing plant, Salmonellae

165 The effect of adding ozone into an intensive broiler production unit on performance, mortality, ammonia levels, and bacterial levels as compared to a non-ozone treated environment. K. Schwan*, H. L. Classen, A. A. Olkowski, E. M. Barber, and C. Riddell, *University of Saskatchewan, Saskatoon, SK Canada.*

Ozone (O₃) is an unstable and reactive molecule that can readily oxidize many organic and inorganic substances. As a consequence, it is also known to be an effective biocide. For these reasons, the use of ozone in a commercial poultry unit could potentially offer two advantages: a reduction in ammonia due to oxidation, and a lower environmental bacterial population. This experiment studied the effect of adding atmospheric ozone (target level of 0.05 ppm) to rooms housing broilers. Broilers (three rooms of five replicate pens, each containing 110 birds) were grown in either a normal environment or an environment with added ozone. Ozone levels were monitored once daily in each pen subjected to ozone. Bird weight and feed consumption were examined on a pen basis at 21 and 40 d of age; mortality was collected daily, and necropsies were performed. Total aerobic bacteria colonies from air samples were plated and counted at 11, 19, and 34 d of age, as well as enterobacteriae at 34 d. Environmental ammonia levels were measured at 15, 20, 28, 32, and 38 d. The addition of ozone caused a near-significant decrease ($P=0.06$) in ammonia levels at 38 d (12.7 vs 25.7 ppm) and total bacterial count at 19 d (142 vs 225 colonies/plate; $P=0.09$). A significant improvement in mortality corrected gain to feed ratio was noted in the ozone-treated birds (0.553 vs 0.535). Birds exposed to ozone grew significantly slower (1.255 vs 1.353 kg gain), ate less (3.695 vs 3.953 kg), and had a higher mortality (11.46 vs 7.33%) and condemnation percentage (10.36 vs 3.39%) than normal environment broilers. These major increases in morbidity and mortality of the ozone-subjected birds make the use of this gas unacceptable for use in a commercial broiler unit, and raise serious health issues for both producers and birds.

Key Words: Ozone, Toxicity, Broiler

166 A Demonstration of Sand as an Alternative Bedding in Commercial Poultry Houses. G.W. Malone*¹, M. Salem¹, D.J. Hansen¹, and M.K. Eckman², ¹University of Delaware, Georgetown, DE/USA, ²Auburn University, Auburn, AL/USA.

Masonry-grade sand (S) is being compared to pine shavings (PS) as an alternative bedding material in paired-house farms under Delmarva production practices. Initial bedding depth was 3.8 cm (S) and 7.6 cm (PS) on 1 paired-house broiler farm, and 8.9 cm (S) and 10.2 cm (PS) on 2 paired-house roaster farms. Following cake removal, no additional bedding has been added since starting this demonstration on the broiler and roaster farms in February and June 2000, respectively. Production parameters (body weight, feed conversion, livability, condemnations, production cost); coccidial lesions and litter oocyst counts; litter quality (gram-negative bacteria, darkling beetle population, temperature, moisture and water activity); and air quality (ammonia and total dust) have been monitored on all farms. Based on the 9 paired-house observations (5 broiler flocks and 2 roaster flocks on 2 farms) to date, initial bedding type has had no consistent influence on most litter quality, air quality and bird performance parameters. However, there are several significant ($P < .05$) treatment effects. For proprietary reasons, all results are reported as the percentage deviation from the control (PS) value. Compared to PS houses, S houses averaged 85% fewer darkling beetles and the litter surface (top 2.5 cm) moisture was 53% and 23% less during the first and last week of production, respectively. Since the moisture determination was a gravimetric procedure, part of these differences can be explained by S having an initial 9-fold higher bulk density than PS. Although total dust was 18% greater in the S houses, birds processed from S houses had 30% fewer total condemnations. Other trends that approached significance ($P < .07$) included; S houses having 2% warmer litter temperatures and 26% higher atmospheric ammonia concentrations during the first week, and 14% higher body weights at market age compared to the PS houses. Although promising, the suitability of S as an alternative bedding for Delmarva production practices can not be fully assessed until a minimum of one year's data is available from these paired-house farms.

Key Words: Broiler, Litter, Sand

167 Effects of density and perch availability on aggressive behavior in broilers. Inma Estevez*, Rosemary Pettit-Riley, and Estelle Russek-Cohen, *University of Maryland*.

Aggressive interactions can both divert energy from growth and potentially reduce well-being of domestic animals. However social behavior, particularly aggressive interactions, has been poorly studied in broiler chickens, perhaps due to the relatively low occurrence as compared to laying hens. Aggressive behavior has been reported to change with varying stocking density. It has also been suggested that perch availability may reduce aggression by providing a place for threatened individuals to retreat. To test the hypothesis that the frequency of aggression in broilers will change with changing stocking density and availability of perches within the environment, groups of broilers were observed from 2 to 6 weeks of age. Both the type of aggression and the pen region in which the interaction occurred were recorded. Birds were housed at densities of 10, 15 and 20 birds/m² corresponding to group sizes of 45, 67 and 90 birds, respectively. In a nested design the birds within each density treatment were assigned to one of the following perch treatments: Horizontal (three 0° perches), 10° angled (three 10° angled perches), mixed angle (one 0° perch, one 10° angled perch and one 20° angled perch) and control (no perches). Results indicate that levels of aggression per bird decreased ($P < 0.05$) with increasing stocking density from 10 to 15 birds/m² (but not from 15 to 20). The main effect of perch treatment was significant for the frequency of threats ($P < 0.05$), but only approached significance for other types of aggression ($P = 0.0584$). Aggression peaked early during week 3 ($P < 0.05$), a result similar to those reported in other studies examining aggression in broilers. Aggressive interactions occurred more frequently in those regions of the pen that were either open or contained perches, rather than in the regions around the feeder or drinker. Results indicate that levels of aggression are dependent on stocking density, and that perch design influence the frequency of aggressive interactions.

Key Words: Broilers, Density, Aggression

168 Effectiveness of a terpene-based product as a broad-spectrum antimicrobial. Julio L. Pimentel*¹ and W. Douglas Waltman², ¹G.V.D. Corporation, ²Georgia Poultry Laboratory.

Two in vitro studies were developed in order to determine the effectiveness of a terpene-surfactant based product (Amibaf). In the first study, seven microorganisms, *E. coli*, *S. typhimurium*, *P. mirabilis*, *P. aeruginosa*, *S. aureus*, *C. albicans*, and *A. fumigatus* adjusted to 10⁵ organism/ml were incubated in BHI broth containing the terpene product diluted at 1:500, 1:1000, 1:2000, 1:4000, 1:8000, 1:16000, 1:32000 and 1:128000. Three replicates of each series of dilutions were used for each microorganism. After adding 0.5 ml of test organisms, tubes were incubated at 35-37 °C for 18-24 hours, growth onto blood agar was observed after incubating for an additional 18-24 hours. The results showed that the terpene product has a broad-spectrum inhibitory or killing activity. *E. coli*, *P. mirabilis*, *S. aureus* and *C. albicans* (yeast) were all inhibited at 1:1000. *S. typhimurium* was inhibited at 1:500 and *A. fumigatus* (fungi) at 1:13,000. In a second study the objective was to determine the inhibitory effect of various dilutions of terpenes against *E. coli* over time. The terpene product was diluted to 1:500, 1:1000, 1:2000, 1:4000, 1:8000, 1:16000, 1:32000 and 1:64000 in BHI and tested at 30, 90, 150 and 450 min. The product was also diluted in saline at the same concentration and tested at 60, 120, 180 and 480 min. At each respective time, 0.5 ml of each dilution was spread onto MacConkey agar plate an incubated overnight at 35-37 °C. The results showed an inhibitory effect of terpenes in broth and saline. In BHI *E. coli* was killed at 1:500 and 1:1000 after 30 min, growth was reduced at 1:2000, 1:4000, 1:8000 and 1:16000 after 90-min incubation. There was a greater effectiveness in saline, *E. coli* was killed at 1:500 after 60 min, at 1:1000 and 1:2000 showed a dramatic reduction at 60 min. After 480 min *E. coli* was completely killed in the 1:500, 1:1000, 1:2000 and 1:4000 dilutions and reduced at 1:8000. The results show that the terpene product has antimicrobial properties and can have several uses in the animal industry because of its GRAS status.

Key Words: Terpenes, Antimicrobial, Biocide

169 Strain and age effects on skeletal growth in two commercial broiler strains. I. Toure*, J. Nixon, and M. Lilburn, *The Ohio State University/OARDC*.

Selection for growth and yield traits in broilers have had positive effects on traits of economic importance but not all aspects of growth and development have been enhanced. There is considerable data in the literature on various aspects of skeletal development in modern broilers but much of the data incorporates measurements with the tibia but not the femur. In the present experiment, broiler chicks from two commercial strains were killed at multiple ages throughout growth for carcass and skeletal measurements. The tibia and femur were removed from each bird for length, width @50% of length, and dried wt determination. The absolute length and width of each bone continued to increase through the entire study (49 d) and there were significant strain differences throughout the study, although the magnitude of these changes varied with age. At 21 d, there were significant strain differences in tibia length ($P \leq .012$) and femur length ($P \leq .014$) but only the tibia length differences carried through to 36 d. At the latter age, however, there were significant differences in both tibia width ($P \leq .011$) and femur width ($P \leq .022$). The data suggest that while there are acknowledged differences in growth and yield characteristics between commercial broiler strains, there are differences in the support structure (i.e. skeleton) as well. These changes in relative support need to be further studied, particularly as bone breakage continues to be of concern in broilers reared to heavier body weights.

Key Words: Broiler, Tibia, Femur

170 Artificial neural network prediction of the weight gain and feed conversion of broilers raised under a range of environmental temperatures. T. L. Cravener*¹, W. B. Roush¹, J. D. May², and B. D. Lott², ¹The Pennsylvania State University, Department of Poultry Science, University Park, PA 16802-3501, ²USDA, ARS, South Central Poultry Research Laboratory, Mississippi State, MS 39762-5367.

Data describing the effects of altering environmental temperature (T) on the BW gain (BWG) and feed conversion (FC) of male and female broilers were gathered over 3 trials. Previously, May et al., (1998; Poultry Sci. 77(Suppl. 1):4) analyzed the data and calculated regression equations (REG) for BWG and FC for both genders. The same data inputs (BW and T) were used in the current study to predict BWG and FC with Artificial neural networks (ANN). Chicks were reared in a common environment until 3 wk of age. At 3 wk they were randomly assigned to 1 of 10 environmental chambers. Each chamber was maintained at a constant T throughout the study; with the T in the 10 individual chambers ranging from 12 to 30 C in two degree increments. Dewpoint was maintained at 18 C and relative humidity was $\leq 82.9\%$. BWG and FC were calculated on a wky basis for 4-7 wk. NeuroShell[®] Predictor software was used to train the four ANN. The REG and trained ANN were placed in a spreadsheet. The difference between the actual value in the database and either the REG or ANN prediction was calculated. The absolute differences were statistically analyzed for significance using a paired t-test. ANN prediction of FC resulted in higher training R² values than BWG. Females tended to have higher R² values than males. The ANN training R² for predicting BWG was 0.83 for females and 0.72 for males. The ANN training R² for predicting FC was 0.91 for females and 0.84 for males. When predictive ability was compared, the ANN predicted more accurately ($P < 0.05$) than the REG. ANN prediction of BWG and FC is a successful alternative to REG and may allow a manager to make critical decisions concerning scheduling and feed inventory requirements on a timely basis.

Key Words: Artificial Neural Networks, Environmental Temperature, Broiler Performance

171 Genetic characterization of commercial broiler lines experimentally infected with Subgroup J Avian Leukosis Virus (ALV-J). M Karaca*, J. K. Rosenberger, and S. S. Cloud, *University of Delaware, Newark, DE*.

This study was initiated to determine the genetic basis for weight gain or immune response in chickens infected with ALV-J. Embryos from 4 genetic lines of chickens were inoculated with the UD-4 isolate of ALV-J by the yolk sac route at 3 days of incubation. An equal number of embryos were sham inoculated. At hatch chicks were vaccinated with NDV and IBV and during grow-out exposed to infectious bursal disease virus, reovirus and chicken anemia virus to simulate commercial conditions. Body weights were measured every 2 weeks. At 5 weeks, chickens were assessed for their ability to clear *E. coli* following intravenous inoculation. This was done because ALV-J is believed to compromise resistance to bacterial infections. Biweekly body weights and *E. coli* blood clearance assays were analyzed using the GLM procedure of SAS. A total of 129 (A=42, B=40, C=47) chickens were genotyped using 33 microsatellite markers. The association of genotype with the phenotypic measurements of body weight and *E. coli* clearance were determined for sham vs ALV-J inoculated chickens. The heterogeneity of each locus was calculated within lines. The average observed heterogeneity of line A, B and C over 33 loci was 30.65 %, 33.31 % and 31.29 % with 3.24, 2.97 and 3.45 alleles per locus, respectively. The average allele sharing between lines A and B was 72.23 %, between lines A and C it was 66.07 % and 61.91 % between lines B and C. Overall, the lines shared 55.38 % of their alleles. The genetic distance between line A and B or C was found to be 25.82 or 27.41 % respectively. Both suggestive ($P < 0.10$) and significant ($P < 0.05$) associations of marker genotypes with quantitative trait loci (QTL) affecting biweekly body weights and clearance of *E. coli* were detected. Two marker loci were found to be significantly ($P < 0.05$) associated with body weight at 2 and 4 weeks of age for line A. One marker genotype had a significant effect ($P < 0.05$ - $P < 0.10$) on clearing pathogenic *E. coli*. Further characterization of the genetic lines is continuing by genotyping progeny tested sires with 100 microsatellite markers.

Key Words: Genotyping, Subgroup J Avian Leukosis Virus (ALV-J), Disease resistance

172 Relationships between skeletal growth and body weight in Japanese quail selected for 4 week body weight. J. M. Reddish*, A. El-Keredy, K. E. Nestor, and M. S. Lilburn, *Dept of Animal Science, The Ohio State University, Ohio Agricultural Research and Development Center.*

A weight selected strain of quail (HW) selected for increased 4 week body weight was compared with a randombred control to investigate the relationship of skeletal growth and selection for body weight. The heavy weight (HW) strain was derived from the randombred control strain (RBC). Body weight differences (HW>RBC) between strains were consistent throughout the experiment. The objective was to investigate the growth of the tibia and femur and determine if selection for resulted in differences between the HW and RBC strains. Measurements were taken of body weight, length and width of both the tibia and femur at weekly intervals from 1 to 35 days of age. Body weight difference (50%) was consistent throughout the experiment (HW>RBC) and growth patterns were similar. Differences in skeletal measures and body weight were only 15% for both RBC and HW ($p < .01$). Correlations for skeletal traits and body weight were positive, and significant ($p < .01$) for RBC thru day 28 but HW showed disruption in this pattern. The results suggest that selection for body weight and skeletal growth are symmetrical in the RBC, but different in HW. The HW strain has proportional growth but does not have symmetry between skeletal traits and body weight as noticed in the RBC strain.

Key Words: selection, quail, growth

173 The effect of selection for increased egg production in turkeys on incubation characteristics of embryos. A. L. Antonelli*, K. E. Nestor, and M. S. Lilburn, *Department of Animal Sciences, Ohio State University/OARDC, Wooster, OH.*

In strains of turkeys selected for egg production (E; Nestor et al., 1980, 1995), genetic increases in egg production are proportional to decreases

in the weight of the albumen and yolk, as well as the total egg weight when comparisons are made to a randombred control line (RBC1). In the present study, E line hens were mated to E line toms or RBC1 toms, and RBC1 hens were mated to RBC1 toms. Egg weight at set was $67.2 \pm .39$ g for E/E eggs, $65.6 \pm .32$ g for E/RBC1 eggs, and $87.16 \pm .68$ g for RBC1/RBC1. At 21 days of incubation, E/E yolk-free embryo weight was 5% less than in E/RBC1 embryos, yet at 25 days there was no differences. At hatch, E/E yolk-free embryo weight was 5% greater than that of E/RBC1 embryos. Overall, the E/E line embryos had a 64% increase in yolk-free weight between 21 and 25 days with overall weight gain of 95%. E/RBC1 had only a 56% increase in yolk-free weight between 21 and 25 days with overall weight gain of 70%. RBC1/RBC1 embryos had an 80% increase in yolk-free weight between days 21 and 25 with an overall weight increase of 118%. At 21 days of incubation, RBC1/RBC1 yolk-free embryo weight was 11% heavier than the E/E line and these differences increased to 25% and 26% at 25 d and hatch (28 d), respectively. The data suggest that genetic differences in embryonic development are maximally expressed from 21 to 25 days of incubation, concomitant with the period of maximal yolk lipid transfer to the development embryo.

Key Words: Turkey, Incubation, Embryo

174 Germ-line transmission of a *lacZ* gene in chickens using an avian Spleen Necrosis Virus-based vector. S. Borwornpinoy*, D.W. McCoy, P.E. Mozdziak, and J.N. Petite, ¹*North Carolina State University.*

Replication-defective retroviral vectors based on the avian spleen necrosis virus (SNV) have been successfully used to produce transgenic chickens. One particular vector, SNTZ, expresses nuclear-directed beta-galactosidase. The SNTZ vector has been used as a cell lineage marker for the analysis of early embryonic development of the chick. The purpose of the present study was to produce transgenic chickens using SNTZ. High titers (2.0×10^7 virion/ml) of SNTZ were injected into the subgerminal cavity of 66 stage X white Leghorn embryos followed by *ex ovo* embryo culture. Of the 66 infected embryos, 16 hatched (24%). To date, of the 16 hatched chicks, 12 have reached sexual maturity. Genomic DNA from blood and semen samples from these G₀ birds were tested for the presence of *lacZ* sequences using the polymerase chain reaction in combination with primers specific for *lacZ*. Out of 7 hens, 2 birds had detectable *lacZ* sequences in their blood. Of the 5 cockerels, 3 were carrying the bacterial *lacZ* gene in the semen. To date, test mating of males and females yielded germ-line transmission from one male at a frequency of 1 out of 20 offspring. No correlation was observed between the presence of *lacZ* sequences in circulating red blood cells and semen. The results of this study suggest that the SNTZ vector can be used to develop a line of transgenic chickens that expresses nuclear-directed bacterial beta-galactosidase. Support was provided through funds under projects NC05293 (PEM), NC06590 (PEM), and NC0168 (JNP).

Key Words: retroviral vectors, germ-line transmission, transgenic

175 Molecular characterization of the genomic chicken prolactin receptor (cPRLR) gene from a native Chinese chicken (Wai Chow strain). Angela Hui* and Frederick Leung, *University of Hong Kong.*

The aim of this study is to clone and characterize the genomic cPRLR gene from a native Chinese chicken (Wai Chow strain). Prolactin receptor (PRLR) participates in a number of physiological functions in birds including reproduction, maternal behavior and osmoregulation. It is widely distributed in many tissues including the brain, the testis and, particularly abundant, in hypothalamus and the anterior pituitary gland. The cDNA of PRLR has been previously shown to consist of an extracellular ligand-binding domain, a single transmembrane and an intracellular domain involved in signal transduction. However, the genomic molecular structure of the cPRLR gene is still lacking. We used the Polymerase Chain Reaction (PCR) trapping method. By designing different pairs of primers flanking the possible intron splice sites, fragments of introns can subsequently be amplified for subcloning and further sequencing analysis. Three introns have been successfully trapped, and the estimated sizes are 1.4kb, 1.5kb and 1.7kb. These DNA fragments were subcloned and further confirmation by DNA sequencing. Consequently, these sequences will be analysed in the databank for any

significance discovered, which helps further understanding of the gene expression pattern and to reveal important pieces of evidences on the gene diversity. Tissue culture will also be carried out to further characterize the promoter region using deletion expression approach.

Key Words: Chicken, Prolactin receptor, Intron

176 Molecular characterization of the chicken prolactin (PRL) gene:genomic gene structure, its polymorphism and promoter analysis. Florence Au* and Frederick Leung, *University of Hong Kong.*

Prolactin (PRL) is a polypeptide hormone of the anterior pituitary gland and has been shown to have a diverse spectrum of biological activities and functions in all vertebrates. Characterization of the chicken PRL gene and its polymorphism is the first step in establishing the genotypes and traits association. Polymerase chain reaction (PCR), cloning and sequencing were used to obtain the four intron sequences of the chicken PRL genomic gene. PCR products indicated that the sizes of the four introns are of 1.5 kb, 0.5 kb, 1.3 kb and 2.0 kb respectively. Sequence analysis of the four PRL introns of the chicken PRL gene revealed that they share high homology with that of the turkey PRL gene and the other strains of chicken PRL gene. In addition, PCR-restriction fragment length polymorphism (PCR-RFLP) was used to identify polymorphic sites within the four introns. An Ava II enzyme cut site in the first intron was found to be polymorphic in Chinese native (Guangdong Xing Hua) chickens. PCR-RFLP was also applied to other chicken strains such as broiler, layer and other native Chinese strain (Shek kai). However, No polymorphism was identified. Present results enable extended study in the PRL gene diversity. In addition, an approximated 2 kb 5' flanking of the cPRL was also obtained by PCR and confirmed by DNA sequencing. Deletion analysis and luciferase reporter gene assay will be used to characterize and define the promoter region in PRL gene expression.

Key Words: Chicken, Prolactin, Polymorphism

177 Detection of a single nucleotide polymorphism in exon 10 of the chicken growth hormone receptor gene. Joanna Lau* and Frederick Leung, *University of Hong Kong.*

Interaction of Growth Hormone (GH) with its receptor (GHR) is required for normal growth in both mammalian and avian species. Defect in GHR gene functions caused by mutation is one of the major causes of genetic disorder, eg. Laron Syndrome and Dwarfism in human and chicken respectively. Recent studies suggest that polymorphisms on both the GH and GHR genes in chicken might serve as genetic markers for phenotypes of commercial values. In this study, a new restriction fragment length polymorphism (RFLP) at exon 10 of the GHR gene has been identified in native Chinese strain chicken, using polymerase chain reaction (PCR) and Alu I restriction enzyme digestion. The same study has been extended to broiler and layers strains and no RFLP was detected. The PCR-RFLP results were further verified by direct sequencing analysis and confined to a single nucleotide polymorphism (SNP) silent mutation at position 924th nucleotide (GA) counting from the translational start site on the published cDNA sequence, resulting in no change in the amino acid. Future studies will be set up to examine whether such mutation has any association with phenotypic traits.

Key Words: Chicken growth hormone receptor, Restriction fragment length polymorphism (RFLP), Single nucleotide polymorphism (SNP)

178 Candidate genes and reproductive traits in a commercial broiler breeder population, an association study. I C Dunn*¹, Y-W Miao¹, A Morris², M N Romanov¹, D Waddington¹, P W Wilson¹, and P J Sharp¹, ¹*Roslin Institute, Roslin, Midlothian EH25 9PS, Scotland,* ²*The Cobb Breeding Company, East Hanningfield, Essex, CM3 8BY, England.*

To take advantage of programmes to identify candidate genes for variation in traits of economic importance, methods to test these genes in selected pedigree populations need to be developed. To this end we have carried out a study of association between candidate genes and reproductive traits in a pedigree line of broiler breeders. Gonadotropin releasing hormone (GnRH), its receptor (GnRHR), growth hormone receptor (GHR) and neuropeptide Y (NPY) were selected for their role in controlling aspects of reproduction. Genetic markers for NPY, GnRHR and

GHR alleles were detected using bulk PCR-restriction fragment length polymorphism or BESS-T Scan (Epicentre Technologies). Genotyping of 772 hens from one generation was by PCR-restriction fragment length polymorphism. Total number of eggs, age at first egg (AFE) and number of double yolked eggs (DY) for each hen were recorded. Additive and dominance effects were fitted for the autosomal GnRHR and NPY genes; additive effects were fitted for the sex linked GHR gene. To control for some of the background genetic variation, candidate genes were assessed within heterozygous sire families. A dominance effect of NPY (14 sire families) on AFE and an additive effect of GnRHR (36 sire families) on DY, were found ($P < 0.02$). If the latter effect were true, selection could increase overall flock performance by 0.13 usable eggs per hen. A simplified model, omitting sires, was also fitted. This analysis gave four significant associations ($P < 0.05$), a surprisingly large number. In conclusion it is possible to detect association between economic traits and candidate genes in a population undergoing selection, and test if a candidate gene explains some of the trait variation. However, statistical associations between trait and genes require to be treated with caution and models should account for as many genetic and environmental variables as possible.

Key Words: Reproduction, Candidate genes, Association

179 Mapping QTL Loci Affecting Growth And Disease Resistance to Avian Coccidiosis. J Zhu*¹, H Lillehoj¹, C Van Tassel², M Emara³, P Allen¹, H Cheng⁴, D Pollock⁵, M Sadjadi⁵, and T Sonstegard², ^{1,2}*U.S.Department of Agriculture, BARC, Beltsville, MD,* ³*University of Delaware, Newark, DE,* ⁴*U.S.Department of Agriculture, ADOL, East Lansing, MI,* ⁵*Perdue Farms, Inc., Salisbury, MD.*

Selection of commercial poultry stocks with improved disease resistance using classical genetic breeding techniques has been unsuccessful due to technical difficulties. Although selection based on progeny tests can be used, this is labor-intensive, time consuming, and costly. In order to develop a DNA marker-assisted selection strategy to improve disease resistance against avian coccidiosis in commercial breeder chickens, chicken genes controlling resistance to coccidiosis are being identified. Three hundred and twenty four F2 offspring for mapping quantitative trait loci (QTL) affecting disease resistance were produced from 12 full-sib families of a commercial broiler breeder. The F2 offspring were inoculated with 104 sporulated oocysts of *Eimeria maxima* at 4 weeks of age. Body weight gain and fecal oocyst shedding were determined as a measure of infection. One hundred and twenty chicken microsatellite markers with an average genome distribution of 20 cM were used for genotyping the F1 and F2 generations. Genotypic data were analyzed with CRIMAP version 2.4 to construct a marker linkage map. A minimum LOD score of 3.00 was used as the statistically significant threshold for declaring linkage. The QTL analysis was conducted using SOLAR on genotypes of the F1 and F2 and the phenotypes of the F2 chickens. A locus on chromosome 1 was identified that was significantly associated with reduced oocyst shedding and 3 potential loci affecting growth were identified on chromosomes 1 and 6. (Supported by Fund for Rural America, Grant No 9704985 and partially by ARS CRIS).

Key Words: Coccidiosis, QTL mapping, Disease resistance

180 The use of molecular markers to associate feather color alleles with tissue pigmentation in broiler chickens. R Okimoto*, *University of Arkansas.*

Consumers dislike black melanin pigment in the abdominal skin and fascia. It has been demonstrated that certain feather color alleles are associated with this pigmentation. The dominant white allele (*I*) and sex-linked barring allele (*B*) are known to reduce the incidence of abdominal pigmentation when coupled with the extended black allele (*E*) of the *E* locus. Since most commercial broilers are white feathered the cryptic feather color alleles that are segregating within the population cannot be determined without test mating. Molecular PCR based markers would facilitate selection against unwanted alleles. We have developed PAMSA (PCR amplification of multiple specific alleles) tests that can distinguish the various *E* locus alleles. These tests detect specific nucleotide substitutions in the melanocortin 1-receptor gene that result in amino acid substitutions in the receptor sequence associated with specific alleles of the *E* locus. In order to test the efficacy of using these tests in selection against tissue pigmentation a cross between two broiler dam lines was made to create an F₁ population that was nearly

fixed for recessive white (*cc*), segregating for sex-linked barring (*B*) and heterozygous for the *I* and *E* loci (*IiEe^b*). F₂ chicks were hatched and 345 were typed for tissue pigmentation at 15 days of age and 1700 were typed at 5+ weeks of age. All F₂ chicks were white feathered due to recessive white (*cc*). Pigmentation ranged from no visible pigment to pigmented birds with a few spots around the navel to large areas of the abdominal region having intense pigmentation. Total incidence of abdominal tissue pigmentation was 27% at 15 days and 23.6% at 5+ weeks. At this time, 79 F₂ chicks have been PAMSA genotyped for their *E* locus alleles, and were found to segregate 1:2:1, as expected, for the *EE:Ee^b:e^be^b* genotypes. As expected, the *EE* genotype was associated with the least abdominal pigmentation (8.7%), while 18.4% of the *Ee^b* chicks and 44.4% of the *e^be^b* chicks were pigmented. Results indicate that selection for the *E* allele in dominant white broiler stocks would decrease the incidence of abdominal tissue pigmentation, and that molecular based tests would facilitate this selection.

Key Words: Broiler, *E* Locus, Pigmentation

181 Effect of dietary protein, photoperiod, and genetic background on growth and sexual maturity in Japanese quail. A. El-Karedy, K. Nestor, and M. Lilburn*, *The Ohio State University/OARDC, Wooster, OH.*

Japanese quail are a valuable species for genetic studies in poultry due to their short generation interval and relative ease of maintenance. The current study included two lines of Japanese quail, a large-bodied line (HW) selected for increased BW at 4 wk of age and a rambred control line (R1) from which the HW line was developed. The selection environment includes a period of reduced daylength and this environment results in sexual maturity (age at first egg) at about 53 d in both lines (Anthony et al., 1993), whereas continuous lighting can reduce sexual maturity by approximately 10 d (Lilburn et al., 1992). The selection diet contains 28 % CP and, in previous experiments, this diet resulted in a significant line by diet interaction for growth and onset of sexual maturity (Lilburn et al., 1992). In the present study, HW and R1 quail were fed one of three diets (21, 24, or 27 % CP) and exposed daily to either an 8- or 24-h photoperiod from hatch to 28 d of age and 24 h thereafter. The R1 hens reached sexual maturity about 2 d earlier than HW hens (49.8 vs 51.9 d; $P \leq 0.004$). The 8-h photoperiod delayed sexual maturity by 12 d (56 vs 44 d; $P \leq 0.0001$) and the 27 % CP diet enhanced sexual maturation by 4 d compared with hens fed either 24 or 21 % CP diets (47.3 vs 51.5 d; $P \leq 0.0001$). There were no significant two-way interactions. As would be expected, the 24-h photoperiod significantly reduced BW at sexual maturity in both lines but there were no significant diet effects. The 24 and 27 % CP diets increased oviduct weight at sexual maturity in HW hens compared with the 21 % CP diet (10.24 vs 9.3 g) and there was no diet effects in the R1 line (5.6 g), resulting in a significant line by diet interaction ($P \leq 0.031$). There was a linear decrease in ovary weight in both lines with each incremental increase in dietary CP but no significant effects due to photoperiod. The data suggest that dietary CP and photoperiod had independent effects on various traits measured at sexual maturity and these effects were not necessarily similar within the two genetic backgrounds.

Key Words: Japanese quail, sexual maturity, genetics

182 Is improved feed conversion associated with increased lethargy and docility in broiler chickens? D. O. Skinner-Noble*¹, R. B. Jones², and R. G. Teeter¹, ¹Oklahoma State University, Stillwater, OK 74078, ²Roslin Institute (Edinburgh), Midlothian EH25 9PS.

An experiment was conducted to test the hypothesis that broilers classified as good rather than poor feed converters (high versus low gain-to-feed ratios, respectively) would show decreased activity (increased lethargy) and reduced fear of human caretakers. The birds (450 large broiler-type) were reared straight run to 36 d of age when they were sexed. Of the 227 males that were then weighed and subjectively evaluated for breast conformation and leg defects, 192 were placed into individual-bird cages (46 x 60 cm) at 40 d of age and their feed conversion ratio (FCR) was measured over the next 7 days. During this time the birds were subjected to three behavioral tests. Firstly, we scored their approach / avoidance responses to a novel object placed in the feeder at a time when feeding would be expected. Secondly, in an assessment of the general behavior patterns of individual birds we recorded feeding, drinking, walking, pecking, preening, standing and

resting. Thirdly, the 20 birds showing the best FCR and the 20 showing the worst were induced into tonic immobility (TI); this test of underlying fearfulness is an anti-predator reaction to manual restraint. We found that feed conversion was not related to either the novel object or the TI measures of fearfulness. Neither was FCR related to feeding, drinking, walking or pecking. However, gain-to-feed ratio was positively correlated with both standing and preening, and negatively correlated with resting behavior. Therefore, contrary to expectations, the present results suggest that broilers that showed good feed conversion ratios were actually less lethargic and no more fearful than those that showed poor FCR values.

Key Words: Feed conversion, Lethargy, Fearfulness

183 Level and pattern of DNA sequence variation in the chicken genome. Edward Smith*, *Virginia Tech.*

Variation among chickens for metabolic and physiological factors are significant indicators of differences in performance and health. Individual variation in physiological and metabolic factors can be influenced by differences in candidate genes. Identification of mutations in these candidate genes as well as the determination of the distribution and structure of the variants in different populations are essential in properly defining their roles. Here results of a DNA sequence-variation screen of five metabolically important chicken genes including type X collagen (*col10*), aggrecan (*agg1*), cyclin D3 (*cycD3*), ovalbumin A (*ovbA*) and chicken PepT 1 (*cpept1*) are described. For each gene, a panel of 48 unrelated birds from six commercial layer-type breeder lines were used without regard to their health or performance status for resequencing of PCR-amplified diploid products. Variable DNA sites or single nucleotide polymorphisms were identified in iterative stages that involved alignment of multiple sequence traces and the identification of heterozygous loci based on context-specific patterns of the individual sequences. Each variable site was re-sequenced at least once and most were aligned in more than one contig. As expected and have been observed in human and mouse, there was significant variation among genes. For example, within the 800-bp sequence evaluated from the 3d end of *cpept1*, a total of 16 variable sites were detected and confirmed. From the *cycD3* gene, however, no variable sites were detected within the coding sequences. Within a total of 40 kb of DNA sequence screened, an average of 1/150 bp of variable sites were detected. The value of this information is at several levels: First, SNP discovery within these functionally important genes will now make it easier to carryout association studies designed to identify genes that influence disease and performance traits. Second, the high frequency of variable sites suggest that biallelic markers may be useful for the construction of a third generation chicken genetic map that can be used for quantitative trait locus identification. (Acknowledgment: Hong Chen, Yuan Pan, Kenny Webb and Eric Wong are gratefully acknowledged for sharing the PepT1 sequence with me prior to publication).

Key Words: chicken, DNA sequence variation, linkage disequilibrium

184 Novel Randomly Amplified Polymorphic DNA Markers for the Turkey Genome. Amy Spellerberg* and Edward Smith, *Virginia Polytechnic Institute and State University, Blacksburg Virginia/USA.*

Though it is a commercially important meat animal species, our knowledge of the turkey genome, relative to the chicken and other species, remains limited. To address this limitation, a publicly available and widely disseminated turkey genome map is necessary. The utility of such a map includes gene discovery and quantitative trait loci identification for economically important traits. To support the development of a turkey genome map, randomly amplified polymorphic DNA (RAPD) markers may be a useful resource. Here we describe a novel set of RAPD markers developed by screening parental samples from members of a turkey DNA reference panel. Using conventional PCR techniques, ninety-six RAPD primers were used in the screening. Amplified products were separated on agarose gels and analyzed for the presence of informative fragments based on Mendelian inheritance. A total of thirty-two primers, or 33.3% of the primers used for screening, revealed polymorphic fragments that showed Mendelian inheritance. These fragments ranged in size from 400 bp to 3 Kb and cumulatively represented the analysis of a 46.8 Kb

portion of the turkey genome. This study establishes that RAPD markers may be a reliable and efficient resource for constructing a genomic linkage map of the turkey genome.

Key Words: Turkey genome linkage map, RAPD markers, polymorphic loci

185 Use of AFLP DNA markers to evaluate genomic diversity and genetic distances in Japanese quail lines divergently selected for stress responsiveness. F. M. Odeh*¹ and G. G. Cadd¹, ¹*Department of Poultry Science, Louisiana State University Agricultural Center, Baton Rouge, LA 70803.*

The secretion of corticosterone is a classic endocrine response to stress in avians. In this study, the genomic diversity and genetic distances in Japanese quail lines divergently selected for stress responsiveness were evaluated using an amplified fragment length polymorphism (AFLP) technique to generate DNA markers. DNA from individuals of extreme performance within each selected line was extracted and pooled for analysis. DNA from five different individuals was pooled for each replicate. Four replicates from each selected line and two replicates from a randomly bred (RB) line were screened by DNA fingerprinting. The enzyme combination *EcoRI/TaqI* was used for a double digestion of the DNA

pools. Fragments with *EcoRI/TaqI*-end were radioactively labeled, separated by molecular weight by gel electrophoresis, and apposed to X-ray film for visualization. Ninety-seven *EcoRI/TaqI* primer combinations generated 20,416 bands with 5,089 of them being polymorphic. The AFLP procedure amplifies a high number of restriction fragments (52 bands, on average, in a single primer combination) and produces markers that are scored as the presence or absence of a band. The average band sharing (BS) values produced from AFLP fingerprinting within lines were 0.590, 0.631, and 0.581 for HS, RB, LS lines, respectively, whereas the average BS values between the lines were 0.573, 0.550, and 0.572 for HS-RB, HS-LS, and LS-RB respectively. The BS values within each given line and between the lines were, however, very sporadic, regardless of primer-combination used and the line analyzed. In this study, 5.5% of the genomic variation was attributed to mutation rate, 0.57% to genetic drift, and 0.057% to bidirectional selection. There were insignificant differences in average genetic distances between the selected lines. Although AFLP failed to resolve genetic diversity between the selected lines, it clearly identified fragments of DNA that may help determine the major genes involved in the stress responsiveness phenotype.

Key Words: Stress responsiveness, AFLP, Genetic distance, Japanese quail

PSA Nutrition: Amino Acids

186 Impact of phase-feeding on growth performance of broilers fed diets adjusted every other day for decreased amino acid content. H.R. Pope*, J.A. Townsend, and J.L. Emmert, *University of Arkansas.*

An experiment was conducted during the finisher period (42 to 56 d) to determine the effects of decreasing dietary amino acid levels as often as every other day using the phase-feeding (PF) approach. Experimental diets were formulated using either NRC recommendations for lysine (Lys), sulfur amino acid (SAA) and threonine (Thr) or recommendations from linear regression equations generated from estimates of Lys, SAA and Thr requirements. To facilitate implementation of PF, two diets were prepared that contained Lys, SAA and Thr levels matching the predicted requirements for birds at 42 d (high nutrient density) and 56 d (low nutrient density). After being properly mixed and pelleted, the high and low nutrient density diets were blended in variable quantities to produce rations containing amino acid levels that matched the predicted PF requirements over two day intervals (42-44 d, 44-46 d, 46-48 d, 48-50 d, 50-52 d, 52-54 d, 54-56 d). Birds were fed either a single NRC diet from 42 to 56 d or a series of PF diets that were switched every other day to supply a gradual decrease in Lys, SAA and Thr. Weight gain, feed intake, and feed efficiency of birds fed the PF regimen were unaffected ($P > 0.05$) relative to birds fed the NRC diet. An evaluation of digestible Lys, SAA, and Thr intake revealed a significant decrease ($P > 0.05$) in Thr intake for those birds given the PF diets, however no differences ($P > 0.05$) in digestible Lys or SAA intake were observed between the NRC and PF diets. These data indicate that dietary Lys, SAA, and Thr content maybe reduced as often as every other day under a PF program in which high and low nutrient density diets are blended without adversely affecting growth performance. Moreover, because dietary Lys, SAA, and Thr levels are decreased under the PF system substantial dietary cost savings may be available with such a program.

Key Words: Broiler, Phase-feeding, Amino Acids

187 Evaluation of lysine and arginine needs in broiler finisher diets. E. A. Oviedo-Rondon*, C. A. Fritts, and P. W. Waldroup, *University of Arkansas.*

Two studies were conducted in floor pens to examine response of male broilers to combinations of Lys and Arg in broiler finisher diets. In the first study, a diet was formulated with 0.75% Lys and 1.0% Arg. Aliquots of the diet were supplemented with Lysine HCl and arginine free base to provide a 3 x 4 factorial arrangement with three Arg levels (1.0, 1.2, and 1.4%) in combination with four Lys levels (0.75, 0.85, 0.95, 1.05%). Each treatment was fed to four pens of 50 male Ross 308 broilers from 42 to 63 d. In the second study, three Arg levels (1.0, 1.1, and 1.2%) were fed in combination with four Lys levels (0.75, 0.85, 0.95, and 1.05%) with each treatment fed to four pens of 50 male Cobb 500

broilers from 42 to 56 d. Body weight gain and feed conversion (FC) were determined and birds were processed for dressing percentage (DP), breast yield (BY) and abdominal fat (AF) content. The level of Arg had no significant effect on BW gain, FC, DP, BY, or AF in either study, indicating that the NRC (1994) recommended level of 1.0% is adequate for this age period. No significant interactions occurred between levels of Lys and Arg for any criteria in either study. In the first study, conducted in moderate temperature, Lys had no significant effect on BW, FC, or DP; BY was increased by 0.85% Lys but higher levels gave no further advantage. In the second study, conducted in high temperatures, BW gain, FCR, and BY were significantly improved by increasing Lys from 0.75 to 0.85% but higher levels gave no further advantage. These data suggest that current NRC (1994) levels of Arg and Lys are satisfactory for broilers during the finisher period of 6 to 8 or 9 wks of age under periods of moderate or high temperatures.

Key Words: Arginine, Lysine, Broilers

188 The influence of dietary labile methyl donors on arginine requirement of young broiler chicks using growth and muscle creatine as parameters. M. Chamrusspollert*, G.M. Pesti, and R.I. Bakalli, *Department of Poultry Science, The University of Georgia, Athens, GA 30602-2772.*

Two experiments were conducted to investigate the effect of methyl donors on the arginine requirement of young broiler chicks. One-day-old Ross x Ross chicks were fed corn-whey based diets for 14 days. Four replicate pens of ten chicks each were randomly assigned to each treatment. At 14 d, two birds from each pen were killed and breast muscles were collected for creatine analysis. In Experiment 1, six levels of arginine (ARG) (0.95, 1.05, 1.15, 1.25, 1.35, or 1.45%) were fed with two levels of methionine (MET) (0.45 or 0.65%). Based on body gain data, the ARG requirement was $1.19 \pm 0.07\%$ or $1.16 \pm 0.06\%$ when chicks were fed the 0.45 or 0.65% MET diet, respectively. The requirement was $1.16 \pm 0.04\%$ or $1.19 \pm 0.06\%$, respectively, based on muscle creatine. However, based on FCR, the ARG requirement of chicks fed 0.45% MET was higher ($1.25 \pm 0.04\%$), compared with those fed with 0.65% MET ($1.16 \pm 0.04\%$; $P < 0.05$). In Experiment 2, two sources of methyl donors, MET or betaine (BET) were compared on an equal percentage basis. Eighteen treatments with 6 levels of ARG (as above) were factorially arranged with no methyl donor supplementation, or 0.2% MET supplementation (0.65% total) or 0.2% BET supplementation (0.2% total). There was no significant interaction ($P > 0.05$) between ARG and methyl donor source on body weight gain and feed intake. The body gain data were pooled to calculate the ARG requirement. Therefore, based on body gain, the ARG requirement was $1.20 \pm 0.05\%$. Based on FCR, we found the interaction between ARG and methyl donor source ($P < 0.05$). Based on FCR, the ARG requirement of chicks fed the unsupplemented diets was $1.29 \pm 0.06\%$, fed diets supplemented MET was $1.24 \pm 0.04\%$,

and fed supplemental BET was $1.15 \pm 0.04\%$. Based on muscle creatine, the requirement was $1.29 \pm 0.06\%$, $1.27 \pm 0.03\%$ or $1.18 \pm 0.04\%$ when chicks fed unsupplemented diets or diets supplemented with MET and BET, respectively.

Key Words: Arginine requirement, Methionine, Betaine

189 Influence of maillard reaction products on *Escherichia coli* amino acid lysine auxotroph growth-based assay response. X. Li* and S. C. Ricke, *Texas A&M University, College Station, Texas/USA.*

Lysine availability in poultry feeds can be rapidly assessed by measuring the growth response of an *Escherichia coli* lysine auxotroph. Maillard reaction formation commonly occurs during food or feed processing that involve heating and can reduce the availability of lysine. It is not clear whether formation of Maillard reactions products (MRP) would inhibit *E. coli* growth and influence the accuracy of the assay. The objective of these studies was to examine the effect of MRP formation on *E. coli* mutants *lys*⁻ and *met*⁻, and wild type K12 growth in model systems. Three different types of MRP were generated by autoclaving glucose with either lysine, arginine, or histidine for more than 3 hours. In model systems, combinations among types of MRP and different concentrations of MRP were added to an M9 minimal medium. The growth response of different *E. coli* strains were examined in the model systems supplemented with 4 µg/ml of required amino acid. Different types of MRP were added to determine the effect of MRP on the lysine assay. There were significantly ($p < 0.01$) different growth rates due to bacterial strain difference, however, addition of different types of MRP or different concentrations of MRP did not cause significant ($p > 0.01$) differences in growth rate. Linearity of the standard curve without adding MRP (control) was not significantly ($p > 0.01$) different from those of the standard curves adding MRP for the lysine assay. The result indicated that the presence of the MRP should not lead to errors in the *E. coli* lysine availability assay of foods or feeds containing Maillard reaction products.

Key Words: Maillard reaction products, Growth rates, Lysine assay

190 Development of a rapid whole cell biosensor for assessing methionine availability by insertion of genes encoding for green fluorescent protein into an *Escherichia coli* methionine auxotroph. C. A. Froelich*, I. B. Zabala Díaz, and S. C. Ricke, *Texas A&M University, College Station, TX/USA.*

The need to accurately measure the levels of bioavailable methionine in poultry and animal feeds remains an important issue in animal nutrition. Techniques ranging from animal, chemical, and microbial assays exist to measure this nutrient's utility. The objective of this study is to develop a rapid microtiter methionine assay for feeds and feed components using a fluorescent *Escherichia coli* methionine auxotroph strain (ATCC# 23798). Initially an *E. coli* methionine auxotroph strain was transformed with plasmid *p519ngfp*, containing a green fluorescent protein gene (*gfp*) coupled to a constitutive promoter that confers a fluorescent phenotype. Transformation was achieved by conventional CaCl₂ method. Plasmid presence was confirmed by antibiotic markers and by gel electrophoresis. Microbial assay was started by placing fully grown and depleted *E. coli* cells in minimal mineral media containing increasing concentrations of methionine and cells were then incubated at 27°C with constant agitation. Fluorescence was monitored using a multi-label counting fluorometer (Victor2V, PerkinElmer, Massachusetts) every 15 minutes for 2 hours set at an excitation/emission wavelength of 485nm/535nm for 1 second. Measuring absorbency at 585nm assessed bacterial growth. Since the bacterial assay was performed at 27°C, cells never left lag phase and A585nm correlated poorly with varying methionine concentrations ($0.5\text{-}2.0 \mu\text{g/ml}$, $R^2 \geq 0.1$). However, bacterial fluorescence during this time assayed correlated with methionine concentrations at lower levels ($\leq 0.25 \mu\text{g/ml}$, $R^2 \leq 0.98$). The proposed method allows more sensitive measurements than conventional microbial assays for methionine bioavailability.

Key Words: *Escherichia coli*, Green Fluorescent Protein, Methionine

191 Sulfur amino acids requirement of slow- and fast-feathering male broilers from 0-21 days of age. A. Kalinowski* and E.T. Moran, *Auburn University, Auburn, AL.*

Corn-soybean meal based diets (C-SBM) are limiting in total sulfur amino acids (TSSA) for broiler development. Differences in feather development are thought to influence the demand for cystine (Cys) thus, TSAA requirement. Two experiments were conducted with fast (Ross x 3F8) and slow (Ross x 308) feathering males from 0 to 3 wk of age. For each experiment, chicks were randomly assigned to 72 battery cages (6 birds/cage) and fed a C-SBM diet (21.5% CP; 3050 kcal ME/kg). A 2 x 4 FAT was used, consisting of feathering rate (fast and slow) in combination with four levels of methionine (Met) (Exp. 1) and Cys (Exp. 2). In Exp. 1 diets contained 0.50% Cys with 0.35%, 0.40%, 0.45%, and 0.50% total Met. Feed conversion (FC) responded linearly ($P \leq .01$) to progressive Met level but not weight gain (WG). No significant interaction occurred between feathering and Met level for either WG or FC suggesting a similar need by both sources of males. The second experiment examined the response to Cys level with feeds having marginal total Met (0.45%) to minimize sparing of Cys. Total dietary Cys progressed from 0.35% to 0.50%. Increasing Cys led to improved FC with fast (cubic response; $P \leq .02$) but not slow feathering birds, whereas WG was unaffected. Nitrogen balance studies conducted concurrently (from day 20 to 21) also failed to establish an interaction between Met level and extent of feathering (Exp.1), but an optimization at 0.45% with both broiler sources was apparent (quadratic response; $P \leq .0001$). Differences in the need for Cys attributable to feathering was detected in nitrogen retention ($P \leq .0001$), and slow feathering males attained an optimum at 0.45% (quadratic response; $P \leq .08$), whereas fast feathering males exhibited continuous improvement to the highest level of Cys (linear response; $P \leq .05$). Although present results indicate a Met requirement approximating 0.50% is appropriate, regardless of feather rate, and agrees with NRC (1994); the advocated Cys requirement is more a reflection of need for slow than fast feathering males.

Key Words: Broilers, Sulfur amino acids, requirement

192 Influence of dietary sodium level on response to source and level of methionine in broiler diets. M. A. Motl*, C. A. Fritts, and P. W. Waldroup, *University of Arkansas.*

Numerous studies have compared DL-methionine (DL-Met) and the hydroxy-methyl analogue 2-hydroxy-4-methylthiobutanoic acid (HMB) as sources of methionine for young chicks with variable results. One possible explanation for differences in results is the sodium content of the test diet, as absorption of DL-Met appears to be Na-dependent while absorption of HMB does not. A study was conducted in which a Met-deficient (0.28% Met) diet based on grain sorghum and soybean meal with 0.15% Na and 0.20% Cl was divided into three aliquots and fortified with additional Na from sodium bicarbonate to provide dietary Na levels of 0.15, 0.20, and 0.25%. Within each Na level, either DL-Met (99%) or HMB (88%) were added in amounts sufficient to provide either 0 or 0.30% Met activity. These diets were then blended in amounts calculated to provide 0, 0.04, 0.08, 0.12, 0.16, 0.20, 0.24, and 0.28% supplemental Met from each source at each level of sodium. Each of the 48 test diets was fed to six replicate pens of six male chicks in electrically heated battery brooders from 1 to 21 d posthatch. Source of Met had no significant ($P < 0.05$) effect on either BW or feed utilization (FU). Sodium level significantly influenced both BW and FU, with an interaction of Met level but not with Met source. At the lower levels of Met, the highest level of Na significantly reduced both BW and FU. As Met level increased no significant differences among Na levels were observed. These data suggest that Na level does not appear to influence the response to DL-Met or HMB as sources of Met under thermoneutral conditions.

Key Words: Methionine, Hydroxy Analogue, Sodium

193 Lysine need of broiler males from 42 to 56 days of age under terms of an ideal amino acid pattern. A. Corzo*¹, E. T. Moran, Jr.¹, and M. E. Jackson², ¹*Auburn University, Auburn, AL*, ²*Degussa-Huls, Kennesaw, GA.*

An "ideal" relationship of amino acids one to the other optimizes utilization of dietary protein. Dietary lysine has been used as the standard in this relationship, and its level prior to slaughter is known to influence final live performance as well as breast meat yield. An experiment

was conducted to measure lysine response by broilers to a finishing feed with the protein formulated to approximate an ideal amino acid pattern (Mack et al., 1999). A total of 1050 Ross x Ross 308 male broilers were randomly distributed into 30 floor pens of an open-sided house and provided common diets from placement until 6 weeks of age. From 6 to 8 weeks birds were fed a corn-soybean meal diet (18% CP and 3250 Kcal/kg ME) having essential amino acids "ideally" related to one another within the limits of practicality based on lysine at 0.85%. Five lysine levels from 0.75 to 1.15% were provided. Birds had continuous access to feed, water and light. Body weight gain was similar among treatments; however, feed conversion improved between the 0.75 and 1.15% lysine levels with an optimum approximating 0.85%. All birds were processed, and no significant differences were observed for abdominal fat, carcass yield without fat, and skinless boneless breast meats. The lysine requirement of 0.85% as advocated by NRC (1994) is in agreement with present results.

Key Words: Broiler, Lysine, Protein

194 Lysine, threonine, and arginine supplementation and effects on performance of young tom turkeys raised in a summer environment. J. Kalbfleisch^{*1}, V. Stangeland², J. Brannon¹, and S. Noll¹, ¹University of Minnesota, St. Paul, MN, USA, ²Stangeland Feed Consulting, Willmar, MN, USA.

The purpose of this study was to determine the response to lysine and threonine in diets of young tom turkeys, and any interaction among levels of lysine, threonine, and arginine to 11 wks of age. At 5 wks of age, 980 male Nicholas turkey poults were randomly sorted into 98 pens so that average starting weights were equal. Performance data was collected at 3-wk intervals. The basal diet was formulated to 92% NRC (1994) threonine, 95% NRC lysine, and 110% NRC TSAA at 3-wk intervals and all diets were supplemented with isoleucine, valine, and tryptophan. The basal diet was primarily composed of corn, soybean meal 47%, meat and bone meal, and canola meal. Diet protein in the basal diet was set by desired threonine level, and sources of L-lysine HCl, DL-methionine, L-arginine, and L-threonine were used to obtain desired supplemental levels of each amino acid. A factorial arrangement was used with three levels of lysine (0, .12%, .24%), two levels of threonine (0, .075%), and two levels of arginine (0, .12%). Average daily temperature ranged from 21°C to 26°C from 5-8 wks and 23°C to 29°C from 8-11 wks of age. At 11 wks of age, body weights were significantly affected ($P < 0.05$) by dietary lysine supplementation, where the .12% supplemented lysine diet performed better than the non-supplemented lysine diet. Threonine supplementation improved body weight by 1.05% ($P < 0.03$). During 8-11 wks of age, feed efficiency was improved by 1.83% with supplemental threonine ($P < 0.002$). The .12% supplemented lysine level, representing 105% NRC lysine, provided a better BW response over the basal lysine level (95% NRC) and high lysine level (113% NRC). Diets supplemented with threonine to 100% NRC provided a better BW response and feed efficiency compared to the non-supplemented threonine level, representing 92% NRC threonine. Interactions among amino acids were not detected except for feed efficiency during 8-11 wks for lysine and arginine.

Key Words: Turkey, Lysine, Threonine

195 Lysine needs of starting chicks and subsequent effects during the growing period. M. T. Kidd^{*1}, J. B. Yeatman¹, and B. I. Fancher², ¹Department of Poultry Science, Mississippi State University, Mississippi State, MS 39762, ²Aviagen North America, Inc., Huntsville, AL 35805.

The lysine requirement for broiler chicks has been studied extensively. Many factors such as protein quality, experimental conditions, dietary nutrients, and genetic strain affect lysine needs of chicks. Because lysine increases protein synthesis and decreases protein degradation in chicks, its requirement may vary as meat-type broiler genetics are improved. We conducted two experiments to evaluate lysine needs during the starter period in a broiler strain cross selected for enhanced white meat yield (Ross x Ross 508). Male broilers were randomly placed in 30 floor pens in two experiments (14 birds/pen in Experiment 1 and 30 birds/pen in Experiment 2). There were six dietary treatments representing graduations of lysine from 80 to 130% of NRC in 10% increments from Days 1 to 18. The lysine deficient diets (0.88% total lysine or 80% of 1994 NRC specifications) were similar in both experiments and were created by blending corn, soybean meal, corn gluten meal, wheat middlings,

poultry fat, and crystalline amino acids. All broilers received a common diet from Days 19 to 41 and Days 19 to 42 in Experiments 1 and 2, respectively. Growth responses were measured for the starter period and birds were processed and deboned at termination to determine effects of starter lysine on breast meat development. Quadratic response curves were fitted to growth performance criteria of chicks. Broilers fed lysine levels below NRC specifications as chicks had reduced growth and carcass attributes at Day 41 and 42. The lysine level required (95% of the upper asymptote) for chick growth responses was between 107 and 111% of NRC (1994).

Key Words: Lysine, Broiler, Amino Acid

196 Broiler growth and carcass responses to diets containing L-threonine versus diets containing threonine from intact protein sources. M. T. Kidd^{*1}, C. D. Zumwalt¹, D. W. Chamblee², M. L. Carden², and D. J. Burnham³, ¹Department of Poultry Science, Mississippi State University, Mississippi State, MS 39762, ²South Central Poultry Research Unit, USDA-ARS, Mississippi State, MS 39762, ³Ajinomoto Heartland, Inc., Chicago, IL 60631.

The third limiting amino acid for broilers is typically Thr and meeting its minimum in least cost formulation with L-Thr results in reduced CP. This experiment evaluated if diets formulated utilizing the supplemental amino acids Met, Lys, and Thr could achieve the same performance as commercially fed diets utilizing supplemental Met and Lys. Ross x Ross 308 broilers (1,440 of each sex) were randomized across 72 floor pens (40 birds/pen). The experimental design consisted of a 2 (sex) x 6 (dietary Thr) factorial arrangement (12 treatments and 6 replications/treatment). Two basal diets, with and without L-Thr, were formulated using identical minimum digestible amino acid values. This resulted in one diet with 600g/ton of L-Thr and one with no L-Thr. These two diets were blended together to make the intermediate treatments which consisted of: 1) a control diet with no L-Thr; 2) as 1 plus 150g/ton of L-Thr; 3) as 1 plus 300g/ton of L-Thr; 4) as 1 plus 450g/ton of L-Thr; 5) as 1 plus 600g/ton of L-Thr; and 6) as 5 with a digestible Thr/Lys ratio of 0.65. Dietary treatments were implemented from Days 1 to 20, 21 to 35, and 36 to 48. Growth responses were measured for each period and carcass responses were measured at Day 49. There were no significant Thr x sex interactions. Also, dietary Thr treatment differences did not occur for any parameter measured. BW gain, feed intake, and carcass parts weights were improved ($P < 0.05$) in male broilers versus female broilers, but female broilers had optimal ($P < 0.05$) feed conversion and livability. Although all treatment diets met adequate minimum levels of essential amino acids, treatment diets containing L-Thr had lower nutrient levels of CP, Ile, Arg, Val, and Trp. Formulating diets adequate in essential amino acids to contain up to 600g/ton of L-Thr does not affect growth or carcass attributes of commercial broilers.

Key Words: Threonine, Broiler, Amino Acid

197 Male and female broiler responses to low and adequate dietary threonine on nitrogen and energy balance. W. A. Dozier, III^{*1}, E. T. Moran, Jr.¹, and M. T. Kidd², ¹Auburn University, AL, ²Mississippi State University, MS.

Mucus associated with the intestine and digestive enzymes from the pancreas have extensive amounts of threonine. Presumably, mucus and enzyme formation would decrease when birds receive feeds low in threonine to adversely affect nutrient recovery. This study compared nitrogen and energy utilization of male and female broilers fed diets previously shown to be either deficient or adequate in threonine for males late in development. A total of 750 male and female broilers were randomly distributed into 30 floor pens of an open-sided house and provided diets that met NRC (1994) nutrient recommendations from placement until 6 wk of age. At 42 d, 48 birds (24/sex) were removed from the floor pens and individually caged in raised wire batteries. Each bird was given feed that was formulated to contain either 0.52 or 0.74% total threonine with 18% CP and 3,200 kcal ME/kg. The treatment structure consisted of a 2 x 2 factorial arrangement with 12 replications per treatment. Two 24-h excreta collection periods were conducted on Days 46 and 54 to measure nitrogen and energy recovery. On Day 46, males receiving 0.74% threonine had an advantage in retention of nitrogen (38.8 vs. 21.5%; $P \leq 0.05$) and recovery of AME_n 3.40 vs. 3.24 kcal/g; $P \leq 0.05$) but energy retention was not significantly ($P \leq 0.05$) different from those given the lower level. Dietary threonine did not affect nitrogen retention with females at Day 46, but contrary to expectation low threonine at 54 d

provided an advantage in nitrogen utilization (19.9 vs. 8.8%; $P \leq 0.05$) over females consuming the higher level. Dietary ME measurements with females were similar at both threonine concentrations and ages. Threonine need appears to be considerably more extensive with males than females, and inadequacies with males that exceed repercussion on N-balance also create conditions that reduce the recovery of ME.

Key Words: Amino Acid, Broiler, Threonine

198 Ideal ratio (relative to lysine) of tryptophan and threonine for chicks during the second and third week of life. A.B. Batal*, T.M. Parr, N.R. Augspurger, C.M. Parsons, and D.H. Baker, *University of Illinois, Urbana, IL USA.*

Three bioassays were conducted to determine the ideal ratios of Trp and Thr to Lys. Young male crossbred chicks (New Hampshire x Columbian) were fed diets based on corn gluten meal and synthetic amino acids (AA) that could be made singly deficient in Lys, Trp, or Thr. Diets for all assays contained 3,400 kcal ME/kg, and L-glutamic acid was used to make all diets (within and among assays) equal in protein at 23.8% of the diet. When fully fortified with each limiting AA, growth performance of chicks fed the corn gluten meal diet was equivalent to that observed with a 23% CP Met-fortified corn-soybean meal diet. True digestibility assessment of corn gluten meal in cecectomized roosters facilitated dose-titration studies (six dose levels for each AA) so that least squares fitted one-slope broken-lines and quadratic regression equations could be calculated to establish inflection points for both weight gain and gain:feed. Four battery pens of four chicks were fed one of six AA dose levels during the period 8 to 22-d posthatching. Weight gain and gain:feed responded quadratically ($P < 0.01$) to increasing doses of digestible Lys (0.68 to 1.28%), Trp (0.09 to 0.24%), and Thr (0.41 to 0.81%). Broken-line least squares analysis predicted breakpoints for gain and gain:feed, respectively, of: Lys (0.85, 0.96%), Trp (0.16, 0.16%), and Thr (0.53, 0.53%). Requirement estimates based on quadratic regression fits (90% of upper asymptote) predicted requirements for gain and gain:feed, respectively, of: Lys (0.97, 1.03%), Trp (0.19, 0.18%), and Thr (0.61, 0.62%). Regardless of curve-fitting method, gain:feed requirements for Lys (but not Trp or Thr) were much higher than weight gain requirements. Using the higher of the broken-line requirement estimates for gain and gain:feed, ideal ratios (% of Lys) were: Lys (100), Trp (17), and Thr (55). The

Trp ratio is similar but the Thr ratio is lower than previous estimates made in our laboratory.

Key Words: Tryptophan, Lysine, Threonine

199 Ideal ratio (relative to lysine) of isoleucine and valine for chicks during the second and third week of life. T.M. Parr*¹, A.B. Batal¹, N.R. Augspurger¹, and D.H. Baker¹, ¹*University of Illinois.*

Three bioassays were conducted to determine the digestible Lys, Ile and Val requirement of male crossbred (New Hampshire x Columbian) chicks during the period 8-20 days posthatching. The chicks were fed semi purified diets based on corn gluten meal (CGM) and amino acids (AA) that could be made singly deficient in Lys, Ile or Val. Diets for all assays contained 3,400 kcal ME/kg, and L-glutamic acid was used as a source of non-specific amino nitrogen to make all diets (within and among assays) equal in protein at 23.8 % of the diet. When fully fortified with each limiting AA, growth performance of chicks fed the CGM diet was equivalent to that observed with a 23% CP Met-fortified corn-soybean meal diet. True digestibility assessment of CGM in cecectomized roosters facilitated dose-titration studies (six dose levels for each AA) so that least squares fitted one-slope broken lines could be calculated to establish inflection points for both weight gain and gain:feed. Each AA dose level in each assay was fed to four battery pens of four chicks. Quadratic ($P < 0.01$) responses to each AA occurred when graded levels of digestible Lys (0.68 to 1.28 %), Ile (0.45 to 0.95 %) or Val (0.51 to 1.06 %) were fed. Breakpoint requirement estimates for gain and gain:feed, respectively, were : Lys (0.85, 0.97 %), Ile (0.59, 0.58 %) and Val (0.74, 0.74 %). Using the higher of requirement estimates for gain and gain:feed, ideal ratios (% of Lys) were : Lys (100), Ile (61) and Val (76). The Ile ratio was lower but the Val ratio was similar to previous estimates made in our laboratory. Breakpoint requirement estimates for gain and gain:feed were similar for all AA evaluated except Lys, where the requirement for feed efficiency was substantially higher than that for weight gain. Quadratic regression fits to the data so that 90 % of the upper asymptote could be calculated predicted higher requirements than those predicted from the breakpoint of the broken-line responses.

Key Words: Ideal Ratio, Isoleucine, Valine

PSA Nutrition: Feed Ingredients I

200 Bioavailability of zinc and copper lignosulfate complexes in broiler chicks. J.L. Grimes, J.W. Spears, and J.L. Godwin*, *North Carolina State University, Raleigh, NC, USA.*

Chickens are usually fed inorganic minerals to meet their mineral requirements. However, organic chelated minerals have been shown to be more bioavailable in some studies than inorganic forms. Two trials (T1 & T2) were conducted to determine the bioavailability of Zn and Cu from lignosulfate complexes (LSC) relative to feed grade sulfate forms. In each trial there were 24 pens with 7 male chicks per pen. In T1, the treatments were as follows: 1) Control - no supplemental Zn (10.1 ppm Zn analyzed); 2) 7.5 ppm supplemental Zn from ZnSO₄; 3)15 ppm supplemental Zn from ZnSO₄; 4)7.5 ppm supplemental Zn from Zn LSC; 5)15 ppm supplemental Zn from Zn LSC, and 6) 7.5 ppm supplemental Zn from Zn proteinate. In T2, the treatments were as follows: 1) no supplemental Cu (2.22 ppm Cu analyzed); 2) 1 ppm supplemental Cu from CuSO₄·5H₂O; 3)3 ppm supplemental Cu from CuSO₄·5H₂O; 4)1 ppm supplemental Cu from Cu LSC, 5)3 ppm supplemental Cu from Cu LSC, and 6)1 ppm supplemental Cu from Cu proteinate. The experimental design was a completely randomized design. In T1 on d 21, tibia Zn (TZ) and plasma Zn (PZ) were determined using four chicks per pen. In T2 on d 21, blood hemoglobin (Hb), liver Cu (LCu), bile Cu (BCu), and plasma Cu (PCu) were determined using four chicks per pen. Feed consumption, by pen, and BW were measured at d 0, 7, 14, and 21. Orthogonal contrasts were made to compare the effect of level and source of mineral on performance parameters in each trial. In T1, increasing dietary levels of Zn from all sources resulted in increased BW, BWG, TZ, and PZ. There was no effect of source on BW, BWG, TZ, or PZ. FC was improved by supplemental dietary Zn while source had no effect. In T2, there was no effect of level or source of Cu on BW, BWG, FC, or LCu. Both level and source of Cu increased BCu. Chicks fed the lower CuSO₄ level had higher BCu than those fed a similar level of Cu LSC. Hb and PCu were increased by supplemental Cu from both

sources. Dietary Zn and Cu LSC were similar in bioavailability to feed grade Zn and Cu sulfates.

Key Words: Zinc, Copper, Bioavailability

201 Evaluation of tetrabasic zinc chloride and tribasic copper chloride for growth promotion and toxicity in chicks. M.E. Persia*, C.M. Parsons, and D.H. Baker, *University of Illinois, Urbana, IL USA.*

Concerns associated with increasing antibiotic resistance of bacteria have cast a negative shadow on the use of sub-therapeutic levels of antibiotics as growth promoters in animals. With increasing legislation prohibiting the use of antibiotic growth promoters, other methods of growth promotion should be explored. High levels of both Zn and Cu have been used in swine diets to promote growth, and high levels of Cu have been used to a lesser extent in poultry diets. The objective of this study was to evaluate two new Zn and Cu compounds, Tetrabasic zinc chloride (TBZC) and Tribasic copper chloride (TBCC), for growth promoting effects and maximum tolerable levels that can be fed in corn-soybean meal diets to chicks. In the first experiment, TBZC (61.8% Zn) was fed at levels of 0, 0.05, 0.10, 0.15, 0.30, 0.50, and 1.00% added Zn. In a second experiment, TBCC (59.8% Cu) was fed at levels of 0, 0.015, 0.025, 0.05, 0.075, and 0.10% added Cu. Feed grade CuSO₄ was also added to supply 0.10% Cu for comparison. In both experiments, four replications of five New Hampshire x Columbian chicks were fed each diet from 8 to 22 days of age. The experiments were conducted in batteries that were left dirty from previous chick exposure. In the TBZC experiment, no differences were seen in weight gain or feed efficiency from feeding up to 0.15% supplemental Zn. A significant reduction in weight gain and feed efficiency occurred at 0.30% added Zn and higher levels. The 1.00% Zn treatment also resulted in increased mortality. In

the second experiment, the addition of 0.015 to 0.050% Cu from TBCC had no effect on chick weight gain, feed intake or feed efficiency. Levels of Cu above 0.050% decreased growth performance. The growth depressions from TBCC and CuSO₄ (0.1% added Cu) were similar in magnitude. Our results indicate that at least 0.15% supplemental Zn from TBZC and 0.05% supplemental Cu from TBCC can be safely fed to chicks.

Key Words: Tetrabasic Zinc Chloride, Tribasic Copper Chloride, Growth Promotion

202 The application of egg by-products as valuable protein supplements in broiler chicken diets. L.D. Schmidt*, B.A. Slominski, D. Boros, L.D. Campbell, and W. Guenter, *University of Manitoba, Winnipeg, MB, Canada.*

Egg by-products have received little attention as a poultry feedstuff despite their excellent amino acid profile, energy content and the presence of anti-bacterial proteins. The nutritive value of the egg by-products was evaluated in two experiments. The first experiment was a completely randomized design in which birds were fed corn-soy diets containing 8% of either fish meal (control), spray-dried technical albumen (SDTA), heat treated (hot room storage at 70°C for 72h) SDTA or heat treated spray-dried whole egg (SDWE). Similar body weight gains (529, 520, 480, 514 g/bird/14days) and feed conversion ratios (1.33, 1.34, 1.38, 1.32) were observed although a negative affect of heat treatment on the nutritive value of SDTA was evident. This was substantiated by reduced TME_n content of SDTA following hot room storage (5.32 vs 4.54 Mcal/kg). Amino acid digestibility, as determined at the terminal ileum, averaged 80-90% for lysine, methionine, cystine and threonine. Based on the results of the first trial a long-term production trial was conducted. Five replicates of 60 birds were fed one of four wheat-soy diets: a positive control containing fish meal and antibiotic (PC), a negative control with no antibiotic added (NC), NC+SDTA and NC+SDWE. The test proteins were included at 6% in the starter phase and 5% in the grower phase. The body weight gain and feed conversion averaged 2.14, 2.12, 2.18, 2.25 kg/bird and 1.68, 1.66, 1.61, and 1.60 for PC, NC, NC+SDTA and NC+SDWE, respectively. The high performance observed for the SDWE diet was substantiated by an increased AME over the PC diet (3212 vs 2956 kcal/kg). In comparison to the PC diet, a trend towards reduced populations of Gram-negative *Enterobacteriaceae* was observed for NC+SDTA (7.78 vs 6.15 Log CFU/g feces). It is evident from this study that the substitution of fish meal with egg by-products could further improve broiler chicken performance.

Key Words: Egg by-products, Nutritive value, Broiler chicken

203 Nutritional value of hydrolyzed whole swine for turkey poults. S. D. Crow*¹, P. R. Ferket, and T. F. Middleton², ¹NC State University, Raleigh, NC USA, ²Ag ProVision, Kenansville, NC USA.

Hydrolyzed whole swine (HWS) meal is produced by an alternative rendering method: ground carcasses were blended with soybean hulls then processed by flash dehydration and dry extrusion. Two experiments were conducted to evaluate the feeding value of HWS for poults. In both experiments, 400 hen poults were randomly assigned to one of five dietary treatments with 10 poults/pen. Four isocaloric and isonitrogenous corn-soy meal based diets, containing different levels of HWS (0,5,10,15%), were formulated to contain 90% of NRC (1994) recommendation for amino acids. A positive control (C) corn-soy diet was formulated to meet 100% NRC (1994) recommendations. All diets contained 0.5% titanium dioxide as an indigestible marker. Poults were housed in Petersime battery cages and fed the experimental diets *ad libitum* from 0 to 18 d of age. Body weights and feed intake were measured at 7, 14, 18 d of age, and fecal samples collected 14-18 d to determine apparent metabolizable energy (AME) content of all experimental diets. Treatment effects were not observed in experiment 1: however, significant effects were observed between the HWS test diets and the C diet for feed to gain (1.37 vs 1.29 P<.006) and g protein intake/gain (2.81, 2.84, 2.83, and 2.76, P<.006). There were no significant differences in growth performance observed among the HWS test diets. In experiment 2, there were no treatment effects observed on weight gain; however, FCR was significantly different P<.001 among the 4 test treatments and the C, respectively (1.24, 1.23, 1.30, 1.36, 1.22), indicating AME of the HWS was over estimated. Based on the AME data, the HWS produced for experiments 1 and 2 was estimated to be above 5250 Kcal AME/kg and

5109 kcal AME/kg, respectively. This study demonstrated that HWS is a high-value feed ingredient that can be included up to 15% in poult diets without adverse effects on growth performance, provided accurate knowledge of energy value.

Key Words: Flash dehydration, Extrusion, Hydrolyzed whole swine

204 Canola meal toasting can be eliminated as it has no positive effects on broiler performance. R.W. Newkirk*¹ and H.L. Classen, ¹University of Saskatchewan, Saskatoon, SK, Canada.

Elimination of toasting during the desolventization of canola meal (CM) would result in higher and more uniform amino acid availability but it is not known if such processing is required to reduce anti-nutritional or toxic factors in the meal. Therefore, the objective of this research was to study the effects of canola meal toasting on broiler chicken performance. Conventional toasted meal (TCM) and a hexane laden, non-toasted meal (NTCM) were collected from a crushing plant. NTCM was desolventized in a research desolventizer toaster without the use of sparge steam. The resulting meal contained low residual hexane and was yellow in color. The meals were fed to 3240 broiler chickens in a 2*2*6 factorial (2 sexes* 2 types of meal* 6 levels) with 45 birds per floor pen from 0-39 d. TCM and NTCM replaced 0, 20, 40, 60, 80 and 100% of the soybean meal (SBM) in wheat based diets. Elimination of toasting increased body weights from 0.606 and 2.148 to 0.618 and 2.181 Kg in 19 and 39 d chickens, respectively. It also improved gain to feed ratio (0-19 d) from 0.637 to 0.642 but did not affect mortality. Replacement of up to 80% and 60% of the SBM in the starter and finisher diets, respectively did not affect growth rate. Higher levels of TCM or NTCM significantly reduced growth rate and feed intake. Total mortality from 19 to 39 d and chronic heart failure (CHF) increased with level of CM addition from 5.19% to 13.89% and 1.85% to 9.63%, respectively. CHF in males, but not females was increased from 3.33 to 17.40% with CM level. In conclusion, elimination of toasting improved broiler growth and feed efficiency and was at least equal to TCM for other parameters. Therefore the production of NTCM may be commercially viable. The highest levels of TCM and NTCM reduced performance and increased mortality indicating maximum inclusion levels of 20 and 15% in starter and finisher diets, respectively.

Key Words: Canola meal, Toasting, Chronic heart failure

205 Nutritional, physiological, and metabolic significance of canola meal sinapine in broiler chickens. H. Y. Qiao*¹ and H. L. Classen¹, *University of Saskatchewan, Saskatoon, Saskatchewan, Canada.*

Sinapine (SNP) is the predominant phenolic compound found in canola meal (CM) and has been considered an anti-nutritional factor in laying hens. Research in broilers has not been known. An experiment was conducted to study the effect of level and source of dietary SNP on male broiler chickens (120 in total). SNP was fed in pure (SB; sinapine bisulphate), semi-purified (EE; CM ethanol extract) or in its native form in CM at three levels equivalent to 15, 22.5 and 30 % CM, and compared to a corn-soybean meal diet. Performance was measured from 0 to 18 days of age, after which birds were killed for measurement of all internal organs and collection of digesta samples for the study of nutrient retention, SNP digestibility, and volatile fatty acid (VFA) production. Feces was collected during the last two days of the experiment. Data were analyzed according to a one-way ANOVA. Dietary treatment did not affect growth rate, feed intake or weight of most organs. Exceptions were that feeding CM increased liver weight, and all diets containing SNP had lower empty cecal weight in comparison to the control. Dietary treatment did not affect VFA production in either the ileum or ceca. Both SB and EE treatments improved fecal AME and protein digestibility in comparison to the control. Digestibility of SNP ranged from 27 to 46 % and 54 to 75 % in the ileum and feces, respectively, and was affected by dietary source and level of diet inclusion. No SNP could be found in the ceca suggesting microbial hydrolysis in this area. Sinapic acid was found in feces samples from birds fed various sources of SNP indicating it is a hydrolysis product of SNP. Dietary SNP in three forms had no impact on the palatability of diets or demonstrate any anti-nutritional effects in the broiler chicken; SNP in SB form may actually provide a beneficial nutritional effect.

Key Words: Sinapine, Canola meal, Broiler chicken

206 Nutrient characterization of guar meal fractions. S.R. Conner, J.T. Lee*, J. Carey, and C.A. Bailey, *Texas Agricultural Experiment Station.*

The annual legume, guar (*Cyamopsis tetragonoloba*) flourishes in arid climates such as north Texas. Currently guar is grown for its galactomannan polysaccharide gum that is utilized as a thickening agent in cosmetics, foods, feeds and oil field drilling mud. Guar meal is the by-product of gum production and has been used successfully in limited quantities as a source of vegetable protein in animal feeds. In the separation of the gum containing endosperm, two distinct fractions are obtained. The first fraction from the splitting of the guar bean has higher germ content and the second fraction removes the hull from the remaining endosperm. A third fraction results from a combination of approximately 22% fraction one and 78% fraction two. Nutrient profiles for the three fractions were determined by proximate and amino acid analysis. The crude protein content of the guar by-product meals averaged 45, 36, and 38% for fractions one through three, respectively. Methionine concentrations averaged 0.53, 0.44 and 0.45% while lysine averaged 2.00, 1.54 and 1.64%, respectively. Dry matter averaged about 91, 94 and 93%. Feeding studies suggest that guar meal can be a viable source of protein for poultry feeds.

Key Words: Guar meal, Proximate analysis, Chickens

207 Evaluation of the feeding value of a non-GMO high-protein soybean meal in broiler diets. B. Lenfestey*, R. Wilson, J. Burton, and J. Brake, *North Carolina State University, Raleigh, NC USA.*

This study was conducted to establish the relative feeding value in broiler diets of a high protein, non-GMO soybean meal (cv. Prolina). Meals were made at a commercial plant from a commercial variety of soybean (Soy-48) and Prolina grown in the same geographical region. Prolina meal possessed higher fiber due to the relatively small lot of beans being air-dried while the standard soybeans were mechanically dried. The difference in soybean moisture caused more hulls to be retained during crushing. Toasted soy hulls or Solka Floc powdered cellulose were used to dilute the Soy-48 to a similar fiber level as that found in Prolina meal. Broiler starter (1.13 kg per bird) and grower diets were formulated to meet or exceed NRC (1994) minimums. Dietary treatments contained the soybean meal sources as follows: Soy-48, Soy-48 diluted with soy hulls (Soy-48+SH), Soy-48 diluted with Solka Floc (Soy-48+SF), and Prolina. The study consisted of four dietary treatments with 8 replicate pens of 25 male broilers per pen. The results showed that Prolina produced a larger BW throughout the study when compared to the appropriate controls, Soy-48+SH and Soy-48+SF, but not different from undiluted Soy-48. The 42-day BW for the Soy-48, Soy-48+SH, Soy-48+SF and Prolina diets were 2.73 kg, 2.67 kg, 2.68 kg, and 2.72 kg, respectively. Unadjusted feed conversion ratio (average = 1.83) showed a slight advantage for the Prolina as well. Percentage mortality was not different across the dietary treatments. The results demonstrate that Prolina SBM has potentially beneficial nutritive traits.

Key Words: Broiler, Body Weight, Feed Conversion

208 Genetically modified rice containing lactoferrin and lysozyme as an antibiotic substitute in broiler diets. Brooke Humphrey*¹, Ning Huang², and Kirk Klasing¹, ¹*University of California, Davis*, ²*Applied Phytologics, Inc.*

Lactoferrin and lysozyme have antibacterial properties, and when combined together their activity is effective against bacteria along the epithelia. Two experiments were done to determine if genetically modified rice expressing human lactoferrin (LF) or lysozyme (LZ) protects the intestinal tract similar to sub-therapeutic antibiotics. Experiment one consisted of ten treatments: corn-soy diet (CS) + 15% conventional rice (control); CS + 0.1% LF; CS + 1.0% LF; CS + 5% LF; CS + 0.2% LZ; CS + 10% LZ; CS + 0.1% LF + 0.2% LZ; CS + 5% LF + 10% LZ; CS + antibiotics (Roxarsone at 0.025%, and Bacitracin at 0.05%). There were no differences in rate of gain or feed intake between any of the experimental rice diets compared to control or antibiotic diets. CS + 5% LF + 10% LZ had significantly better feed efficiency than the control rice diet. Chicks fed CS + 5% LF + 10% LZ had thinner lamina propria in the duodenum and jejunum compared to all other diets ($p < 0.05$). The number of leukocytes per villi was lower in chicks fed lactoferrin, lysozyme, antibiotic, and combination diets compared

to controls ($p < 0.05$). Experiment two had five diets: CS + 15% conventional rice; CS + 10% LZ; CS + 5% LF + 10% LZ; CS + antibiotic (Roxarsone at 0.025%, and Bacitracin at 0.05%); CS without rice. There was no effect of diet on rate of gain. Chicks fed CS + 10% LZ and CS + 5% LF + 10% LZ had significantly lower feed intake and significantly better feed efficiency than those fed the control rice diet ($p < 0.05$). The results from these experiments demonstrate a potential of genetically modified lactoferrin and lysozyme rice to be used as a substitute for antibiotics.

Key Words: Lactoferrin, Lysozyme, Chicken

209 Evaluation of high available phosphorus corn with and without phytase in diets for growing turkeys. C. A. Fritts*¹, F. Yan¹, H. L. Stilborn², and P. W. Waldroup¹, ¹*University of Arkansas*, ²*DuPont Specialty Grains.*

This study was conducted to compare normal yellow dent corn (YDC) and high available phosphate corn (HAPC), fed with and without phytase, in diets fed to growing turkeys. The HAPC contains approximately 0.27% P of which 0.17% is estimated to be available to the poult. The YDC contains approximately the same total P but only 0.03% available P. Substitution of YDC with HAPC will reduce the amount of phytate-bound P in the diet and consequently reduce the amount excreted. Diets were formulated with either YDC or HAPC to contain NRC recommended levels of nonphytate P levels to 20 wk. By removal of dicalcium phosphate and adjusting limestone, test diets were produced that contained reduced levels of P (-0.0%, -0.05%, -0.10%, and -0.15% of NRC) for both the YDC and HAPC. Each of these was fed with or without 1000 units/kg phytase (Natuphos, BASF) for a total of 16 treatments. Each treatment was fed to three pens of 20 male turkeys to 20 wk. At 4, 8, 12, 16, and 20 wk birds were weighed, feed consumption determined, and two birds per pen killed for tibia ash determination. Source of corn had no significant effect on BW, feed conversion, or mortality during the study. Birds fed diets with HAPC had significantly greater tibia ash than those fed YDC at 4, 8, and 12 wk. Addition of phytase significantly improved BW at 4, 8, 12, and 16 wk; at 20 wk turkeys fed phytase were heavier but difference was not significant. Tibia ash was significantly improved at all ages by phytase. No interactions were observed between source of corn and phytase supplementation. Although no fecal samples were taken in this study, the use of HAPC in conjunction with phytase supplementation and reduced P levels should play an important role in a program to reduce P excretion by turkeys.

Key Words: High available phosphorus corn, Phytase, Turkeys

210 Effect of dietary conjugated linoleic acid (CLA) on the growth and fat accumulation of broilers. M. Du*, K. C. Nam, S. J. Hur, H. Ismail, D. U. Ahn, and J. L. Sell, *Iowa State University.*

Two experiments were conducted to investigate the influence of dietary conjugated linoleic acid on the growth and fat accumulation in broilers. In experiment I, 50 three-week-old broilers (total 200 birds) were assigned to one of the diets containing 0%, 0.25%, 0.5%, or 1% CLA and fed for three weeks. In experiment II, 40 three-week-old broilers (total 120 birds) were assigned to one of diets containing 0%, 2%, or 3% CLA and fed for five weeks. Results showed that dietary CLA did not influence the growth, feed consumption, and abdominal fat accumulation in broilers. At the end of 3-wk feeding trial, the average body weight of broilers for Experiment I was about 2.20 kg per bird. For experiment II, after 5-wk feeding trial, the average body weights of birds were 4.04kg, 3.99 kg, and 3.93 kg for control, 2%, and 3% CLA groups, respectively, and were not significantly different. There were no differences in abdominal fat weight, liver fat content, serum triglyceride and cholesterol levels, and feces extractable lipid content. However, dietary CLA reduced monounsaturated fatty acid content, but increased saturated fatty acid content in tissues. Abdominal and subcutaneous fats from birds fed high levels of CLA (2% and 3%) were much firmer than those from control diet. The result of this experiment was unexpected, because dietary CLA has been consistently shown to reduce fat accumulation in rats, mice, and pigs. The reason for the ineffectiveness of CLA in reducing fat accumulation in birds is not clear. However, the major difference in fat metabolism between birds and rodents, where liver plays a central role in synthesizing triglycerides in birds and fat

tissues play a major role in rodents and pigs, could have contributed in part to the ineffectiveness of CLA in reducing fat accumulation in birds.

Key Words: Broiler, Conjugated Linoleic Acid, Fat Accumulation

211 Conjugated linoleic acid alters egg yolk fatty acid composition and hepatic histopathology of laying hens. Gita Cherian^{*1}, Troy B. Holsonbake¹, Mary P. Goeger¹, and Rob Bildfell², ¹*Department of Animal Sciences, Oregon State University,* ²*College of Veterinary Medicine, Oregon State University.*

The effect of dietary conjugated linoleic acid (CLA) along with n-3 polyunsaturated fatty acid (n-3 PUFA) on yolk fatty acid profile and hepatic lipid accumulation was investigated. Single Comb White Leghorn laying hens (n=40) were randomly assigned to four experimental diets containing 0, 0.5, 1.0, or 2.0% CLA. Menhaden oil was used as the source of n-3 PUFA. The total fat content of the diet was 3%. Hens were fed the diets for a period of six weeks. Six birds from each treatment were sacrificed and histopathological evaluation of the hepatic tissue was determined. Total lipid and fatty acid composition of the eggs were determined on day 1, 3, 6, 9, 12 and 15. Dietary CLA did not affect the total lipid content of egg yolk (P >.05). Addition of CLA resulted in an increase in saturated fatty acids (P <.05) with a concomitant reduction in monounsaturated fatty acids (P <.05) in the yolk. The amounts of CLA isomers (cis-9 trans-11, trans-10 cis-12) in the egg yolk were proportional to the levels of CLA in the diet (P <.05). The total CLA content in the egg yolk constituted to 0, 1.4, 2.7 and 5.4%, respectively (P <.05) on day 15 of feeding. Dietary CLA at all concentrations resulted in an increase (P <.05) in the total number of fat vacuoles in hepatocytes. The number of cells with 75% or higher lipid vacuolation in the cytoplasm were also increased (P <.05) by 2.0% CLA. Dietary CLA at all levels resulted in an increase (P <.05) in the total lipid content of hepatic tissue.

Key Words: Conjugated Linoleic Acid, Egg Fatty Acid, Liver Histopathology

212 Feeding various dietary levels of high oleic high oil corn and typical yellow dent corn to laying hens. 1. Live performance and egg production. H. L. Stilborn*, M. Araba, D. W. Rice, M. Hinds, and B. L. Smith, *DuPont Specialty Grains, Des Moines, Iowa, USA.*

High oleic high oil corn (HOHOC) contains an elevated level of oleic acid compared to typical yellow dent corn (YDC), in addition to the increased oil (energy) present in the kernel. The benefit of HOHOC would be not only the increased metabolizable energy present but also the increased oleic acid, which may improve the oxidative stability and fatty acid profile of eggs. A study was initiated to examine if varying the percentages of HOHOC and YDC in layer diets would affect hen performance and egg production. Eighteen-week old hens were randomly assigned to cages and given a standard pre-conditioner diet prior to starting the study. Fifteen cages with 5 hens per cage were utilized per treatment. The corn-soybean meal based diets involved blending the corns at different levels to provide 5 diets: 100/0, 75/25, 50/50, 25/75 and 0% YDC/100% HOHOC. Isocaloric and isonitrogenous mash diets were fed ad-libitum for seven periods (28 days/period). Live performance and egg production parameters were measured during the study. Results indicate body weights of hens were not influenced by the blending level of each corn used in the study, since the diets were formulated to the same nutrient requirements. Feed intake/hen/day, feed/dozen eggs and feed/kg of egg were not affected by corn source or the blending level of each corn. Egg production increased as dietary HOHOC increased. The greatest egg production came from hens fed diets containing at least 50% of the corn source as HOHOC. Further additions of HOHOC to 75 or 100% of the dietary corn source numerically improved egg production compared to hens fed the 50/50 blend. Feeding HOHOC to laying hens in isocaloric and isonitrogenous diets supports similar live weights, feed efficiency (per dozen eggs or per kg of egg) and optimum egg production versus hens fed diets containing only YDC as the corn source.

Key Words: High oleic high oil corn, Laying hens, Live performance, Egg production

213 Feeding various dietary levels of high oleic high oil corn and typical yellow dent corn to laying hens. 2. Egg quality parameters. H. L. Stilborn*, M. Araba, D. W. Rice, M. Hinds, and B. L. Smith, *DuPont Specialty Grains, Des Moines, IA USA.*

A study was initiated to examine how varying the inclusion levels of high oleic high oil corn (HOHOC) and typical yellow dent corn (YDC) in layer diets would influence egg quality parameters. Eighteen-week old hens were randomly assigned to cages and given a standard pre-conditioner diet prior to starting the study. Fifteen cages with 5 hens per cage were utilized per treatment. Corn-soybean meal based diets involved blending the corns at different levels to provide 5 diets: 100/0, 75/25, 50/50, 25/75 and 0% YDC/100% HOHOC. Isocaloric and isonitrogenous mash diets were fed ad-libitum for seven 28 day periods. Egg quality parameters, egg cholesterol, TBA values, yolk vitamin E content and fatty acid profiles were measured. Feeding hens diets containing HOHOC at 75 to 100% of the dietary corn source supported the heaviest egg weights compared to the treatment fed hens. Shell thickness, Roche color score as well as Minolta l, a and b values were not affected by corn source or the degree of corn blending. Albumen height was greatest from eggs of hens fed 25/75 and 0% YDC/100% HOHOC diets. Yolk and albumen weights were heavier from hens fed diets with at least 75% of the corn source represented by HOHOC. Egg TBA values generally increased with increased storage time. However egg TBA levels increased at a slower rate as dietary HOHOC inclusion increased, particularly during days 6 and 12 of storage. Yolk vitamin E levels increased and egg cholesterol content decreased as dietary HOHOC content increased. Yolk oleic fatty acid increased, linoleic decreased, oleic:linoleic ratio increased, conjugated linoleic acid decreased and monounsaturated fatty acid levels increased as dietary HOHOC inclusion level increased. Feeding HOHOC, especially at 75% of the dietary corn source, in isocaloric and isonitrogenous diets supported optimum egg quality parameters. Blending level between HOHOC and YDC tended to influence some egg parameters.

Key Words: High oleic high oil corn, Laying hens, Egg quality, Cholesterol, Fatty acids

214 Nutritional evaluation of Bt (MON810) and Roundup Ready[®] corn compared with commercial hybrids in broilers. A.M. Gaines*, G.L. Allee, and B.W. Ratliff, *University of Missouri-Columbia.*

Experiments were conducted to compare the nutritional value of insect protected (containing CryIA (b)protein, Bt) corn, glyphosate-tolerant (Roundup Ready, RR) corn, their near isogenetic parents (BtC and RRC) and three commercial corn hybrids (C1, C2, and C3). In a 14-day growth assay, 3-day old male broiler chickens were weighed and allotted into 50 pens (6 birds/pen) using a complete randomized design. For each treatment, the five corn hybrids (Bt, BtC, C1, C2, and C3) were included in the diets at the same percentage. The performance parameters of ADG, ADFI, and G:F were determined. No differences were observed in terms of ADG; however, differences (P <.05) were detected for ADFI and G:F. Birds on the BtC diet had a lower ADFI while birds on the C1 diet tended to have poorer G:F. Subsequent to the 14-day growth assay experiment, 35 pens (6 birds/pen) were used to evaluate apparent metabolizable energy values. Diets consisted of only the corn hybrid supplemented with vitamins and minerals. Feed disappearance and fecal output were determined. Dry matter and gross energy values were obtained for the feed and fecal matter. No differences in apparent metabolizable digestibility coefficients were observed (P >.05) due to corn hybrid. In an additional 14-day growth assay, 3-day old male broiler chickens were weighed and allotted into 50 pens (5 birds/pen) using a complete randomized design. For each treatment, the five corn hybrids (RR, RRC, C1, C2, and C3) were included in the diets at the same percentage. The performance parameters of ADG, ADFI, and G:F were determined. No differences (P >.05) in performance parameters were observed. Following the growth assay, 35 pens (5 birds/pen) were used to evaluate apparent metabolizable energy values. No differences in apparent metabolizable digestibility coefficients were observed (P >.05) due to corn hybrid. In conclusion, Bt and RR corns were nutritionally equivalent to their near isogenetic parents; however, there were slight performance differences among the three commercial corn hybrids tested.

Key Words: Corn, Broiler, Growth

PSA Processing and Products: Poultry Meat Safety and Eggs

215 Application of lactic-acid-producing bacterial cultures to skin of live broilers. J. A. Cason*, R. J. Buhr, A. Hinton, Jr., M. E. Berrang, and N. A. Cox, *Russell Research Center, Athens, GA USA.*

In four trials, lactic-acid-producing bacterial cultures were applied to the skin of live broilers 24 h before slaughter to determine whether inoculation of the cultures could affect the numbers of bacteria that are normally found on the skin of processed broiler carcasses. The cultures contained 10,000 to 100,000 cfu/mL and were sprayed in 250 mL of a pH 6.0 nutrient medium (including glucose, peptone, beef extract, yeast extract, a surfactant, and salts) to enhance the growth and survival of the cultures. With broilers suspended by the feet, feathers were moved aside to apply as much of the liquid as possible directly to the skin. Sprayed broilers were then returned to a pen. In each trial, 4 five-wk-old broilers were sprayed and 4 broilers were kept as untreated controls. The following day, broilers were processed in a research processing facility and defeathered carcasses were sampled by rinsing for 1 min in 100 mL of peptone water after removal of heads and feet. Coliforms, *E. coli*, lactic-acid bacteria, and *Campylobacter* were enumerated by standard methods. After removal of aliquots for plating, the remaining sample volume was enriched to detect salmonellae. No differences were found in log₁₀(cfu/mL) of coliforms, *E. coli*, or lactic-acid bacteria between the treated and control carcasses. All carcasses were *Campylobacter*-negative. Salmonellae were present on some carcasses, but with no differences between treatments. Spraying lactic-acid-producing bacteria with nutrients on the skin of live broilers appears to have no effect on numbers of bacteria that are present on the skin after defeathering.

Key Words: Lactic acid bacteria, Skin, Broilers

216 Microbiological consequences of skin removal prior to evisceration of broiler carcasses. M. E. Berrang*, R. J. Buhr, and J. A. Cason, *USDA-ARS-Russell Research Center.*

The skin of broilers can harbor high numbers of bacteria. If broiler processing could be altered such that the skin is removed early like feathers, feet and heads, perhaps a large proportion of these bacteria could be left behind. The objective of this project was to determine if removal of skin prior to evisceration lowers the number of bacteria that can be recovered by whole carcass rinse or outer surface sponge sampling. Two sets of experiments were conducted, one with each type of sampling (rinse or sponge). On each of three replicate sample days, ten New York dressed carcasses were obtained from a commercial broiler processing plant, five were aseptically skinned and five were left with skin intact. On each carcass, the esophagus was tied and cut above the proventriculus allowing the crop to be removed toward the head to prevent contamination of the body cavity. The carcasses were then aseptically eviscerated by hand. Carcasses were either rinsed in 100 mL sterile water or sampled by moist sponge over the outer surface. Serial dilutions from the rinse or sponge were plated on Campy cefex agar, *E. coli* petrifilm plates and plate count agar. Data are reported as mean log₁₀ cfu per sample. When sampled by rinse, 5.4 *Campylobacter*, 4.4 *E. coli* and 6.7 total aerobic bacteria were recovered from carcasses with intact skin. Significantly less *Campylobacter* (4.7) and total aerobic bacteria (5.8) were recovered from skin-off carcasses. No difference in *E. coli* counts was noted for whole carcasses rinsed without skin (3.9). When sampled by sponge, 4.5 *Campylobacter*, 3.7 *E. coli* and 5.6 total aerobic bacteria were recovered. Significantly less *Campylobacter* (2.0), *E. coli* (2.3) and total aerobic bacteria (3.3) were recovered from carcasses without skin. Although not commercially practical, it is possible to lower the level of bacteria including *Campylobacter* on the outside of broiler carcasses by removal of the skin prior to evisceration.

Key Words: Broiler skin, *Campylobacter*, *E. coli*

217 In Plant Microbial Profile of Air Chilled Chickens. W. M. Fluckey*, M. X. Sanchez, M. M. Brashears, E. Wallner-Pendelton, A. Aguilar, M. Tamayo, and S. R. McKee, *University of Nebraska, Lincoln, NE.*

Many factors influence the microbial profile of chicken carcasses at retail. These factors include growout conditions at the farm as well as plant processing methods. To date there has been little data available to establish a microbial baseline for the air chilling poultry process in

the U.S. because this method of chilling is primarily used in Europe. In a one-year period, birds representing 24 farms were evaluated for total aerobic microorganisms, coliforms, psychrotrophs, generic *E. coli*, *Salmonella* spp. and *Campylobacter* spp. Broilers were sampled at three sites during processing: before evisceration (BE), after evisceration (AE), and after chill (AC). Approximately a 0.5 log reduction in aerobes, coliforms and generic *E. coli* was observed AE compared to BE. An additional 0.5-1-log decrease in these populations was observed AC. *Salmonella* spp. and *Campylobacter* spp. enumeration was more variable. When *Salmonella* and *Campylobacter* counts were high, decreases in populations occurred AE and AC. Most often, higher prevalence of *Salmonella* and *Campylobacter* in the plant was related to flocks that came from farms with an open pond water source contaminated with these pathogens. This data suggest that water source contamination on the farm may play a larger role than higher counts of *Salmonella* and *Campylobacter* found in the plant and that numbers of bacteria on chicken carcasses are reduced as the birds proceed through the processing environment. Although there is a reduction in bacteria during processing, high initial loads of bacteria on carcasses entering processing facilities equates to higher bacterial loads after processing.

Key Words: Air chilling poultry, *Salmonella*, *Campylobacter*

218 Development of Time/Temperature Indicator Tags for Tracking Poultry Product Quality Throughout the Cold Chain. C.M. Moore*¹ and B.W. Sheldon¹, ¹*North Carolina State University, Raleigh, NC/USA.*

Time-temperature integrators (TTIs) offer a means of continuously monitoring the temperature of a food product from the point of manufacture to the consumer's refrigerator. TTIs readily indicate temperature abuse and are used to clearly indicate the end of shelf life based on the product's temperature exposure. Currently, no work has been published on the application of TTIs to poultry products. This study was conducted to develop and validate VITSAB-Cox-brand TTIs for monitoring fresh chicken quality throughout the cold chain. VITSAB-Cox TTIs change color from green to yellow to indicate the end of shelf life. Chroma [$\sqrt{(a^2 + b^2)}$] was used to objectively indicate TTI progress. Total bacterial plate counts and *Pseudomonas* species counts were used as quality indicators for chicken drumsticks. Raw chicken drumsticks (n = 4) and VITSAB TTIs (n = 5) were stored at four constant temperatures to identify their Arrhenius activation energy (E_a) which is a measure of temperature sensitivity. The E_a for *Pseudomonas* and for the total indigenous population were determined to be 21.7 ($r^2 = 0.94$, SE=3.8) kcal per mole and 22.5 ($r^2 = 0.97$, SE = 2.9) kcal per mole, respectively. The E_a for the TTI based on its chroma was determined to be 19.8 ($r^2 = 0.98$, SE = 2.2) kcal per mole. Shelf life studies were conducted at constant temperatures (3C and 4.5C) and under fluctuating temperature conditions (stepwise change between 4.5C and 14.5C) with TTIs attached to individual packages of drumsticks. For both constant and variable temperature studies, the TTIs correctly indicated the end of the drumsticks' shelf life. The chroma readings were significantly correlated ($p \leq 0.0001$) to *Pseudomonas* populations [$r = 0.85$ (4.5C), $r = 0.93$ (3C), $r = 0.77$, 0.87(variable temperatures)] and total microbial growth [$r = 0.86$ (4.5C), $r = 0.93$ (3C), $r = 0.8$, 0.91(variable temperatures)]. These findings demonstrated that the VITSAB-Cox TTIs were effective in predicting the end of shelf life of refrigerated and temperature-abused chicken drumsticks as defined by *Pseudomonas* and total aerobic bacterial populations.

Key Words: Time Temperature Indicators, Poultry Products, Shelf Life Prediction

219 Effects of three packaging systems on the natural microflora and acceptability of fresh broiler breast meat. Nadege Charles and Sally K. Williams*, *University of Florida, Gainesville, FL/U.S.A..*

A study was conducted to investigate the effects of three packaging systems on the spoilage microflora, objective color and sensory characteristics of fresh commercial broiler chicken breast meat packaged for retail marketing. Fresh chicken broiler breasts were purchased from a local poultry processing plant and packaged in either (1) conventional styrofoam tray with polyvinyl chloride over-wrap and absorbent pad (PAD), (2) styrofoam tray with polyvinyl chloride over-wrap minus the

pad (PAD), or (3) Fresh-R Pax™ container (FRP) equipped with absorbent liner-gel system. All packages were heat sealed and stored at 1.21 C for 8 d. At each sampling period (0, 2, 4, 6 and 8 d), three packages from each treatment were analyzed for *Pseudomonas sp.* and psychrotrophic organisms, objective color and sensory characteristics. The data revealed similar results for all packaging systems. In general, the *Pseudomonas sp.* and psychrotrophic counts increased as storage time increased for all packaging systems. The color and sensory characteristics (i.e., odor and overall appearance) were similar for all packaging systems. While the absorbent pad used in the conventional tray-pack system and the absorbent liner-gel system incorporated into the Fresh-R Pax™ did not function to control microbial growth, they maintained aesthetic appeal by absorbing all visible moisture released from the meat during storage. This study also suggested that the Fresh-R Pax™ system would function well in reducing free purge in bulk packaged fresh meat and poultry, especially during transport.

Key Words: Packaging, Microbiology, Shelf life

220 Effect of packaging systems on bacteria survival on processed poultry. J. A. Byrd*¹, A.R. Sams², D.J. Caldwell^{2,3}, L.F. Kubena¹, and B.M. Hargis^{2,3}, ¹USDA-ARS, Southern Plains Agricultural Research Center, College Station, TX, 77845, ²Texas A&M University, Department of Poultry Science, ³Texas A&M University, Department of Veterinary Pathobiology, Texas Agricultural Experiment Station.

Previously, we evaluated the effects of modified atmosphere packaging (MAP) gases on the survival of naturally occurring *Campylobacter* on raw poultry and found that O₂ was the most effective in reducing the bacteria. Presently, we evaluated the effects of packaging methods on the survival of naturally occurring *Campylobacter*, aerobes, and psychrophiles on whole or parts of raw poultry. Whole or parts from broiler carcasses (400) were packaged with MAP, ice pack, chill pack, vacuum pack or frozen and sampled for detection of *Campylobacter*, psychrophiles, and total aerobes at 0, 2 and 14d of refrigerated (2°C) storage. MAP gases evaluated were 100% O₂ and a standard mixture (5% O₂ + 10% CO₂ + 85% N). The rinse fluid was recovered, pooled from 5 individual rinses, and serial dilutions made for examination of *Campylobacter* (campy-cefex, 42°C, 48h), psychrophiles (plate count agar, 4°C, 7d), and total aerobic bacterial populations (plate count agar, 37°C, 24h). *Campylobacter* counts for all treatment were reduced during the 14d storage period but the O₂ and frozen treatments caused a significantly (P<.05) greater reduction than the other treatments. Storage for 14d in chill or ice packs resulted in the greatest growth of psychrophilic (spoilage) bacteria. Psychrophilic growth was reduced by frozen, O₂, and gas mixture methods with the mixture having the greatest reduction. Freezing, followed by storage in MAP gas mixture, O₂, and chill pack parts, caused the greatest reduction of aerobes through 14d. These data suggest that O₂ may be a preferred MAP environment because it actually reduced *Campylobacter* detection and retarded both psychrophile and aerobe growth during storage.

Key Words: *Campylobacter*, Modified atmosphere packaging, Storage

221 Application of Active Packaging Films to Inhibit *Salmonella* Typhimurium on Broiler Drumstick Skin. B.W. Sheldon*¹ and P.L. Dawson², ¹North Carolina State University, Raleigh, NC/USA, ²Clemson University, Clemson, SC/USA.

The incorporation of bacterial inhibitors in biodegradable primary packaging films that are applied to fresh poultry products has the advantage of not only providing a hurdle for controlling pathogenic organisms at the processing plant but also throughout the entire marketing and distribution cold chain. The objective of this study was to develop and characterize the inhibitory activity of casted corn zein and heat-pressed wheat gluten packaging films containing varying combinations and concentrations of nisin, lauric acid, citric acid, and Tween 80 on inactivating a nalidixic acid-resistant strain of *Salmonella* Typhimurium on broiler drumstick skin. Following application to the skin and subsequent refrigeration, triplicate skin samples were taken at 42, 88, and 168 hours and the population of surviving *S. Typhimurium* cells estimated following a skin rinse and surface plating technique on BHI agar supplemented with 800 ppm nalidixic acid (37C, 48h). In comparison to control samples that were overlaid with films lacking any inhibitors, a significant reduction in the *S. Typhimurium* populations was detected in the films containing the inhibitors. The maximum inhibition detected was 1.23

(168 h) and 2.17 logs (44 h) for the corn zein and wheat gluten films, respectively. Those films containing multiple inhibitors such as nisin and lauric acid or nisin, lauric acid, citric acid, and Tween 80 produced the greatest inhibition. Reduction of microbial pathogens and spoilage microorganisms on fresh poultry products by safe and naturally occurring antimicrobials (i.e., bacteriocins and organic acids), achieved in a practical and economical way such as by packaging films, could contribute to a significant decrease in the incidence of human disease and the attendant costs. Furthermore, these active package delivery systems could also be utilized at the retail level to further assure the safety and quality of poultry products throughout retail marketing.

Key Words: Inhibitory Packaging, Nisin, *Salmonella* Typhimurium

222 Effect of electron beam irradiation on poultry meat safety and quality. S. J. Lewis*, A. Velásquez, S. L. Cuppett, and S. R. McKee, University of Nebraska-Lincoln Lincoln, NE.

FDA approved the use of irradiation for the control of salmonellae in poultry in 1990. Doses of 1.5 to 3.0 KGy in raw packaged poultry were established as guidelines in 1992. The purpose of this study was to determine whether electron beam irradiation doses of 1.0 and 1.8 KGy could eliminate bacteria in boneless, skinless chicken breasts. Microbial testing was done in triplicate with each treatment consisting of 10 samples. Four breast fillets in a covered/polystyrene tray constituted one sample. Results show that the average populations for coliforms, generic *E. coli*, and psychrotrophs were 11.0, 11.6, and 21.4 CFUs/ml, respectively, in the control samples. However, no populations were detected after the samples were irradiated at a dose of 1.0 or 1.8 KGy. An average level of 254.8 CFUs/ml was detected for aerobic bacteria in the control samples. Irradiation doses of 1.0 and 1.8 KGy reduced the levels to 1.3 and 0.4 CFUs/ml, respectively. Irradiation also rendered the breast fillets free of *Salmonella* and *Campylobacter*. Consumer taste panels were also conducted using a 9-point Hedonic scale to evaluate quality parameters of irradiated poultry. Three sets of each treatment group were randomly selected, individually packaged, and stored for 0, 14, and 28 days at -4°C. Results indicated that the irradiated samples stored for 28 days were less appealing with increased drying and a decrease in the texture, flavor, and overall acceptability. Degree of oxidation was also tested in the breast fillets using TBAR analysis. Within each storage period, TBAR values increased as the level of irradiation increased. In addition, as storage time increased, the TBAR values also increased. Results also indicated that the irradiated samples had higher "a" values, indicating they were "pinker" in color when compared to the controls. In this study, irradiation of the breast fillets proved to be effective in the elimination of bacteria with an improvement in the breast fillet color, but quality of irradiated samples decreased with increasing storage time.

Key Words: irradiation, electron beam, quality of poultry meat

223 Consumer poultry preparation habits and opinions concerning food safety, irradiation, and hormones in El Paso, TX and Las Cruces, NM. K. G. Maciorowski*¹, S. G. Birkhold², and S. C. Ricke², ¹Delaware State University, ²Texas A&M University.

One hundred and fifty supermarket shoppers were surveyed at random in El Paso, TX and Las Cruces, NM to determine poultry preparation habits and opinions concerning food safety, irradiation, and hormones. The respondents were generally older than 26 and 60% were female. The respondents were mostly either Hispanic (70%) or Caucasian (21%), and the majority (68%) possessed a high school education or less. Consumers believed that either pork (26%) or poultry (21%) was the most dangerous meat, with 27% citing no difference. A majority (57%) of consumers believed that bacterial issues were paramount for poultry, but 67% did not use a meat thermometer. Thermometers were most often used for whole birds (11%) or during holidays (12%). Poultry was generally frozen (48%) and thawed in a refrigerator (41%) before use. Television (29%) and family (20%) were most often cited as the most influential source of food safety information. Fifty-five percent of respondents claimed to have had foodborne illness, with either bacteria (17%) or spoiled food (13%) thought to be the culprit. Thirty percent would eat irradiated poultry, while 66% believed that hormones are used in poultry production. Educational programs could be best targeted via television, or by family nutrition counseling.

Key Words: Consumer, Survey, Meat Preparation

224 Egg production and quality response of commercial laying hens molted with alfalfa diets. K Medvedev*¹, C Woodward¹, X Li¹, L Kubena², D Nisbet², and S Ricke¹, ¹Texas A&M University, Department of Poultry Science, ²USDA-ARS, Food and Feed Safety Unit.

Molting is a process that is used throughout the commercial egg industry to extend production in older laying hens. Common industry practices usually involve the removal of feed for a period of several days. It has been shown that molting by feed deprivation can cause a higher risk of *Salmonella* contamination in eggs. This coupled with the increasing awareness of molting practices by consumers has led to the need for alternative molting procedures. One such alternative is feeding alfalfa as an insoluble fiber source during molt. In this study, hen egg production and several quality factors were evaluated in hens that were feed deprived or fed alfalfa meal or pellets for a period of nine days. Hens were kept on a 8h:16h (light:dark) lighting program during the molting period. After the molting period, all hens were placed on layer ration *ad libitum* and a 16h:8h lighting program. Factors investigated include: date of reentry into production, air cell size, egg length, egg weight, egg circumference, albumin height, and yolk height. Post molt egg production in alfalfa pellet (61.24%) and alfalfa meal (55.14%) was shown to be significantly higher ($p \leq 0.05$) than feed deprivation (54.38%). All other quality measurements were consistent across all molting treatments in this study. This data suggests that birds molted using an alfalfa diet will produce eggs in comparable quality and number to birds molted by feed deprivation.

Key Words: Alfalfa, Egg production, Molt

225 Conjugated Linoleic Acid Alters Egg Yolk Fatty Acid Composition and Volatile Compounds in Raw, Cooked and Irradiated Eggs. Gita Cherman*¹, Troy B. Holsonbake¹, Mary P. Goeger¹, and Dong U. Ahn², ¹Department of Animal Sciences, Oregon State University, ²Department of Animal Science, Iowa State University.

The effect of dietary conjugated linoleic acid (CLA) along with n-3 polyunsaturated fatty acid (n-3 PUFA) on yolk fatty acid composition and volatile compounds in raw (R), hard boiled (HB) or hard boiled eggs irradiated (HBI) at 2.5 kGy were investigated. Single Comb White Leghorn laying hens ($n = 40$) were randomly assigned to four experimental diets containing 0, 0.5, 1.0, or 2.0% CLA. Menhaden oil was used as the source of n-3 PUFA. Eggs collected after six weeks of feeding were analyzed for fatty acids ($n = 6$) and volatile compounds ($n = 4$). The content of C22:6 n-3 was reduced ($P < 0.05$) in eggs from hens fed high CLA diet. The contents of cis-9 trans-11 CLA and trans-10 cis-12 CLA in the egg yolk were 3.2 and 1.6%, respectively, for 2.0% CLA diet, and 0.9 and 0.35%, respectively, for 0.5% CLA diet ($P < 0.05$). Total volatiles were reduced in R eggs from 1.0 and 2.0% CLA diets. 2-Propanone, hexane and methyl cyclopentane were the major volatiles in R eggs and were reduced by dietary CLA at 1.0% and 2% levels. Acetaldehyde, pentane, propanol, acetic acid methyl ester, acetic acid ethyl ester, propionic acid methyl ester, 2-methyl-methyl propionic acid, 2-propanone and octane were the major volatiles in HB eggs and was reduced by 2.0% CLA ($P < 0.05$). No difference was observed in the acetaldehyde, pentane, propanol, acetic acid ethyl ester, octane and total volatile content of HBI eggs ($P > 0.05$).

Key Words: Conjugated linoleic acid, Yolk fatty acids, Egg volatiles

226 Effect of electrostatic application of MaxSpray on *Salmonella* Enteritidis attached to the surface of eggs. S. M. Russell*¹, ¹The University of Georgia.

A study was conducted to evaluate the effect of MaxSpray (N-Alkyl dimethyl benzyl ammonium chloride) in combination with an electrostatic spraying system (ESS) on populations of *Salmonella* Enteritidis (SE) coated onto the surface of eggs. Forty eggs were washed and sanitized using a chlorine based sanitizer. The eggs were rinsed thoroughly in deionized water to remove any residual sanitizer. Eggs were submerged into 1% peptone broth containing actively multiplying SE. Thirty of the eggs were placed into a plastic egg flat in the ESS chamber. MaxSpray solution (3600ppm) was prepared using sterile deionized water and electrostatically sprayed onto the eggs using two-10s bursts every hour for 6 h. A total of approximately 800mL of MaxSpray solution was used. The remaining 10 control eggs were treated by electrostatically spraying them with tap water using the same procedure as

for the MaxSpray. Three eggs were also evaluated after immersion into SE and drying to determine how many SE attached to the egg. After treatment, the contents of each egg were aseptically removed and each shell was placed into a neutralizing solution. One mL of this solution was then placed into 9 mL of brain heart infusion broth (BHI) and vortexed. One mL of this solution was then placed into Bactometer module wells in duplicate. Bacterial growth was monitored using the Bactometer Microbiological Monitoring System 128. Three replicate trials were conducted. Microbiological tests indicated that for the three replicate trials, the initial inocula averaged 185, 370, and 120 SE/mL, respectively. SE was recovered from all control eggs, which had an average impedance detection time (DT) of 8.8, 8.7, and 8.0 for unsprayed control eggs, respectively, and 9.8 h for controls sprayed with tap water. Results demonstrated that MaxSpray was able to completely eliminate all SE on 19/30 (63%), 28/30 (93%), and 24/30 (80%) eggs in trials 1, 2, and 3, respectively. For eggs that remained contaminated with SE, the average DT significantly increased from 9.8 for the controls to 10.6, 11.1, and 13.3 (MaxSpray treated) in trials 1, 2, and 3, respectively, indicating a significant decrease in the number of SE. Thus, MaxSpray, in combination with ESS, appears to be an effective means of eliminating SE from egg surfaces.

Key Words: *Salmonella* Enteritidis, MaxSpray, Electrostatic Spraying System

227 Why the Haugh Unit is wrong. F. G. Silversides*¹ and T. A. Scott², ¹Agriculture and Agri-Food Canada, Charlottetown, Canada, ²Agriculture and Agri-Food Canada, Agassiz, Canada.

The Haugh Unit was developed in the 1930s as a means of measuring the quality of an egg by measuring the height of the inner thick albumen. The Haugh Unit formula converts the height to a log scale because albumen height declines in a logarithmic fashion with storage, it uses a scale between 0 and 100, and it adjusts the height for the weight of the egg. The difficulties are in adjusting the height for egg weight, and in using a measure of the height of the inner thick albumen as a measure of egg quality. Eggs from ISA-White and ISA-Brown hens between 25 and 59 wk of age were stored at room temperature for 1 to 7 d to produce a data set with known variation in the three most important determinants of albumen height. Age and storage had the expected effects on egg size, yolk, shell and albumen weights, and albumen height. Regressions of albumen height on egg weight calculated for groups of eggs separated by age of hen and storage period for each strain varied between -0.058 and 0.102 mm per gm egg wt. The Haugh Unit formula uses a fixed regression of 0.05 mm in albumen height per gm egg weight and in this sample of eggs would have introduced a bias into the measurement of egg quality. The use of the log scale in the Haugh Unit suggests that early researchers used albumen height as a measure of freshness, and it is clear that albumen height decreases with storage. The height of the inner thick albumen is associated with levels of the protein ovomucin, which is extremely viscous. However, only 1.5 to 3.5 % of the total protein in albumen is ovomucin and other proteins with good foaming properties make up much larger proportions of the albumen. It is not clear from the scientific literature that moderate differences in albumen height are associated with altered functional characteristics of the egg, suggesting that the most appropriate use of albumen height is to measure freshness. In this sample of eggs, storage, strain of hen, and age of the hen all affected albumen height, imposing a bias on the measure of freshness which was not seen for albumen pH. Measuring freshness of eggs by the height of the inner thick albumen introduces a bias against old hens and some strains of hen, and adjusting the albumen height by applying the Haugh Unit formula further confounds the problem.

Key Words: Egg quality, Albumen height, Haugh unit

228 The effect of cryogenic cooling with carbon dioxide on the USDA grade and microbial load of shell eggs in the commercial setting. L.A. Hughes*¹, K.E. Anderson¹, and P.A. Curtis¹, ¹North Carolina State University.

To determine the effects of cryogenic cooling on the USDA grade and microbial quality of shell eggs, a commercial scale prototype CO₂ cooling unit was placed in a commercial processing facility. Shell eggs were processed using an 8400 Diamond Washer/Grader. Eggs were washed, candled, and sorted for size then passed through the cryogenic prototype cooler prior to packaging. Eggs were packaged automatically and palletized prior to storage in a walk-in cooler (7C). Two trials were conducted, 12 and 15 week periods, respectively. On a weekly basis 18 dozen

of eggs were selected for grading samples based on USDA random sample selection process. Physical quality of intact shell eggs was significantly improved using cryogenic cooling. The difference in the percentage of AA, A, and B eggs began to differentiating after approximately 5 weeks of storage. Eggs cooled cryogenically maintained a higher AA quality throughout the storage period. A random sample of eggs was also selected to evaluate the shell surface and interior content microbial level. The microbial counts of the content of the cryogenically cooled eggs were significantly higher ($p < 0.0001$) compared to traditionally cooled eggs in trial one. It was determined that the cooler sanitation was lacking during the first trial. A cleaning and sanitation protocol was developed for the cooler then the trial was repeated. Internal microbial loads between the two treatments were not significantly different in trial two, after the improvements were made. External microbial counts were higher for cryogenically cooled eggs ($P < 0.002$) in both trials. The increased internal microbial level of cryogenic cooled eggs in trial 1 was due to the lack of cleaning and sanitizing of the cryogenic cooler. The physical quality of the eggs was better in the cryogenically cooled group, with no difference in apparent microbial quality. These trials led to improvements in the design of the equipment, which have been made in the commercial unit. These improvements will facilitate cleaning the equipment, reduce the shell surface microbial load, and improve the physical quality of the eggs.

Key Words: Cryogenic cooling, Shell eggs, Microbial load

229 Comparison of quality and functionality of traditionally and cryogenically cooled shell eggs. K.C. McAvoy^{*1}, P.A. Curtis¹, K.M. Keener¹, K.E. Anderson², and D.E. Conner³, ¹Department of Food Science, North Carolina State University, ²Department of Poultry Science, North Carolina State University, ³Department of Poultry Science, Auburn University.

Previous studies have found that cryogenic cooling of shell eggs results in, a lower Salmonella enteritidis level, a higher quality egg, and a longer

shelf-life than traditional cooling. This research was designed to compare quality and functionality of traditionally cooled eggs to cryogenically cooled eggs from a commercial egg processing plant. Three replicate runs of each of the two treatments were processed to give a total of six treatment reps. Data for cooling curves was obtained by inserting temperature probes attached to data recorders into an egg from each treatment rep. Two hours after processing the cryogenically cooled eggs had reached 11.6°C while the traditionally cooled eggs were at 28°C. Eggs from both treatments were held in refrigerated storage (4°C) during the fifteen-week testing period. Functionality and quality tests conducted include: Haugh units, displacement and specific gravity measurements of angel food and sponge cakes, emulsion stability of mayonnaise, shell and vitelline membrane strength, pH, whipping height and overrun. Haugh unit values were measured every week; all other functional and quality tests were conducted tri-weekly. Data was analyzed using the General Linear Model (GLM) of SAS (1996). Means were separated using the least square method. Cryogenic cooling of shell eggs with carbon dioxide increased the percentage of AA quality eggs compared to traditional cooling. The traditionally cooled eggs dropped from Grade AA to Grade A approximately one week prior to those from the cryogenic treatment. The average Haugh unit values for the fifteen-week testing period were 69.8 and 67.6 for the cryogenically and traditionally cooled eggs, respectively. There were no statistical differences in functionality measurements between the two treatments. Cryogenic cooling of shell eggs with carbon dioxide gas is a viable option for improving safety and quality of shell eggs. This enhanced safety and quality should have significant economic benefit to egg producers.

Key Words: Cryogenic Cooling, Shell Eggs, Functionality

Biotechnology, Animal Products, and the Food Industry

230 Is DNA or protein from feed detected in live-stock products? Kevin Glenn*, Chair, ABSTC Subcommittee on DNA Detection.

With the advent of highly sensitive analytical technology such as polymerase chain reaction (PCR), the need for documentation regarding the potential for the detection of DNA and protein from biotech crops in meat, milk, and eggs (MME) is critical. This is not a concern over the safety of the transgenic DNA or protein in MME since the introduced proteins undergo rigorous review prior to approval, and the UN FAO and WHO, the U.S. FDA and the U.S. EPA have all stated that DNA in food, including transgenic DNA in biotech crops, is a safe, natural component of food. However, it is well recognized that significant logistical problems would be incurred for meat, poultry, egg, and milk processors if labeling and segregation of products from animals fed biotech crops could occur using new detection methods. The scientific studies that have attempted to detect transgenic DNA or protein in MME derived from animals fed biotech crops will be reviewed. To date, the scientific evidence clearly shows that the transgenic DNA and proteins cannot be detected in MME products and that these products are equivalent in every way to products from animals fed conventional feeds. In addition, new data will be presented from studies in which DNA and protein were extracted from chicken breast samples from animals fed YieldGard[®] or conventional corn. PCR followed by Southern blot hybridization was used to analyze the DNA for the presence of specific fragments from the Bt cry1Ab gene and the gene encoding the corn protein ADP glucose pyrophosphorylase (sh-2). None of the extracted DNA samples was positive for cry1Ab or sh-2. The extracted DNA was shown to be of high quality and amendable to PCR amplification of the chicken ovalbumin gene. In addition, data from a new competitive immunoassay sensitive to both intact and partially digested Cry1Ab protein will be presented, showing that this transgenic protein or immunoreactive fragments of the protein cannot be detected in the breast samples from chickens fed YieldGard[®] grain.

Key Words: Polymerase Chain Reaction, Transgenic DNA, YieldGard[®]

231 Preventing food allergy - The impact of biotechnology. James D. Astwood*, Monsanto Company, St. Louis, MO.

People who suffer from food allergies manage their condition by avoidance strategies such as diet eliminations and careful examination of ingredient labels. Unexpected exposures and resulting adverse reactions to food allergens represent the main challenge in food atopy. Unlike hay fever and respiratory allergies, immunotherapy has achieved only limited success because of the potency of food allergens - i.e., immunotherapy with food allergens can often trigger serious side effects, including anaphylaxis. Biotechnology has had a positive influence on the science of food allergy by facilitating the discovery and characterization of allergens using recombinant DNA methods. Today, it is generally accepted that most major allergens have been identified and described. Subsequently, biotechnology has enabled the development of diagnostics based on recombinant allergens and more recently has been used to engineer potentially safer immunotherapeutic versions of food allergens - the creation of de-allergized variants. This will allow safer immunotherapies since the de-allergized variants of food allergens should produce fewer, if any, side effects. In addition, DNA vaccines based on these variants are being tested presently, with a view of providing long-lasting immunotherapeutic options for food allergy patients. Biotechnology is also providing prophylactic options through the development of hypoallergenic foods which have either been engineered to contain fewer endogenous allergens, or have been modified by the presence of proteins like thioredoxin, to render endogenous food allergens less potent and less allergenic. Hypoallergenic foods could reduce the incidence of new food allergies on a global basis.

Key Words: Biotechnology, Allergy, Food

232 The risks of going non-biotech. Thomas P. Redick*, Law Offices of Thomas P. Redick, Del Mar, CA.

Many companies see product lines that are free from modern biotechnology (non-biotech) as necessary to satisfy consumers who may want "non-GMO" foods, including meat, eggs and milk from animals fed non-GMO feed. Before making this leap, however, companies should analyze

potential liability risks of non-GMO products. Product liability risks include potential increases in carcinogenic mycotoxins, such as aflatoxin, which may concentrate in milk or meat (unlike the rDNA in digested GMO (“biotech”) feeds). The comparative product liability risks of rDNA (“biotech”) and non-biotech choices may actually dictate the use of biotech. Moreover, environmental liability risks may be reduced by biotech feeds (e.g., low-phytate soybean meal to reduce phosphorus in animal waste); the EPA could require such feeds as the “best available control technology”. Companies may find that rDNA plant breeding, on a case by case basis, minimizes the environmental impacts of the traditionally bred crops and their associated inputs. Finally, assuming equal safety profiles for biotech and non-biotech feed, a company that goes “non-biotech” risks consumer fraud liability. An affirmative “non-biotech” representation should follow an agreed standard acceptable to all stakeholders. Without careful legal and scientific management of the process behind “non-biotech” representations, companies face fraud suits over unwanted “biotech” content. Until regulators endorse a process for non-biotech certification, dropping the “tolerances” for DNA content in food or feed (i.e., a process standard comparable to USDA’s new Organic Rule), the risks of going non-biotech may often outweigh the benefits. Consumers know about biotech content from intensive media campaigns, so biotech content without a non-biotech claim is not a fraud risk. Since some consumers will ignore reduced mycotoxins and improved environmental performance in favor of non-biotech sources of food, regulations should ensure peaceful co-existence between organic farming and commercial agriculture, but ensure continuing innovation that reduces product liability risks, environmental impacts, and consumer fraud.

Key Words: Food biotechnology, Food safety, GMO

233 Economic and practical considerations of using non-biotech grain in U.S. livestock and poultry feed. Scott Richman*, *Sparks Companies, Inc., Memphis, TN.*

Given concerns about the continuing acceptance of agricultural biotechnology among U.S. consumers, some companies may consider offering for sale meat and poultry produced from animals which were fed only non-biotech grains and protein meals. This avenue may be considered as a way to protect a company’s market share in the event that U.S. consumer attitudes toward biotechnology turn negative, or it may be seen as an opportunity for a company to serve a niche market of consumers who prefer “natural” foods and are willing to pay a premium. Yet, there are practical considerations which constrain the ability of livestock and poultry firms to offer meat and poultry certified as coming from animals fed only non-biotech corn and SBM. At the farm level, biotech varieties of corn and soybeans have been adopted widely across the U.S.

Genetics of Disease Resistance

235 Transgenic approaches to prevent bovine mastitis. D. E. Kerr*¹, K. D. Wells², and R. J. Wall², ¹*University of Vermont, Burlington, VT,* ²*USDA-ARS, Beltsville, MD.*

Transgenic animal technology is a strategy likely to play a major role in the prevention of animal disease. One approach is to enable the production of novel antibacterial proteins by the mammary gland as a means to enhance mastitis resistance. To this end, we have produced transgenic mice that have the ability to produce a bioactive variant of lysostaphin in milk. Lysostaphin, which is normally produced by *Staphylococcus simulans*, has potent staphylococcal activity. The lysostaphin-transgenic mice exhibit substantial resistance to staphylococcal mastitis. Fortification of milk as a strategy to enhance disease resistance has also resulted in reports of transgenic mice whose milk contains human lysozyme, bovine tracheal antimicrobial peptide, or a neutralizing antibody to a strain of murine hepatitis virus. We are currently evaluating additional antimicrobial proteins as candidates to be secreted by the mammary glands of transgenic animals. Our selection strategy is based on a number of parameters. First, there must be no indication of toxicity to eukaryotic cells. Second, the selected protein or peptide must be effective in milk in reducing the growth of mastitis pathogens. Milk components such as negatively charged casein micelles, and milk fat globule membranes can markedly reduce the activity of cationic antimicrobial peptides. Third, antibacterial activity must have limited or no enzymatic activity against milk proteins to ensure product quality. Fourth, the mammary epithelium must be able to produce the protein of interest in an active form.

At the grain elevator, corn mills and soybean crushing facilities, grain from different sources is commingled. Many animal feeding operations would face challenges unless they switched entirely to non-biotech feeds. There would be difficulty in keeping the resulting meat separate from commodity meat in packing and processing plants. The objectives of this talk are to describe the constraints which exist in the current supply chain, to indicate the steps which must be taken if those constraints are to be overcome, and to estimate the costs involved with undertaking such an effort.

Key Words: Economic, Biotechnology, Livestock

234 Effects on Global Trade: Setting International Food Standards via Codex Alimentarius. Mark Mansour*, *Attorney and Partner, Keller and Heckman LLP, Washington, DC.*

Although the Codex Alimentarius Commission has functioned as part of the U.N. Food and Agriculture Organization since 1962, its activities, until recently, were of little more than incidental interest to the international food and feed industries, especially U.S.-based multinationals. However, with the advent of the World Trade Organization (WTO) and the establishment of NAFTA and other regional trading blocs, Codex’s deliberations became significantly more important to government and industry alike. As manufacturers realized that Codex, in the absence of any other mutually acceptable arbitral mechanism, would be enshrined in the WTO as the means by which disputes over trade in food products would be resolved, member countries also realized that the Commission would provide a solution to the growing gaps in their food regulatory structures. Lesser developed countries lacking both the expertise and the budgets to fully develop food regulatory structures adequate for both the protection of public health and streamlining the free flow of goods found such expertise through the 37 year long deliberative process, during which period they have institutionalized in their own regulatory regimes the experience gleaned from delegates representing the industrialized countries of North America and Europe. Despite the progress made in many countries toward developing coherent food legislation and regulatory structures, there remain significant gaps in the laws of many jurisdictions, particularly in Asia, the Middle East and Latin America, as well as persistent confusion about the legality of ingredients, additives and preservatives, and the propriety of various types of claims. In no functional area have these developments been as vital as in the area of biotechnology where, during the course of the next year, Codex is poised to make a series of decisions that will have a significant, and perhaps irreversible impact on the future of the global trade in food and feed products derived from biotechnology.

Key Words: Biotechnology, WTO, Food trade

For many antibacterials this will likely require additional genes to enable post-translational processing and activation. Fifth, activity against bacteria normally used in the production of fermented dairy products must be considered. Lastly, the potential exists for the development of resistant microbial strains. This potential should be reduced by the simultaneous production of multiple antibacterial proteins. Transgenic mice producing lysostaphin in milk represent a proof of concept for the generation of mastitis resistant transgenic cows. Additional proteins will be needed to prevent coliform and streptococcal mastitis.

Key Words: Lysostaphin, Milk

236 Immunogenomics and the periparturient dairy cow: letting leukocytes tell us their own story about disease susceptibility. J.L. Burton*¹, ¹*Michigan State University.*

Despite rigorous management practices aimed at environmental cleanliness, good nutrition, and even vaccination, mastitis remains a problem in periparturient dairy cows. This is partly due to well-known leukocyte dysfunctions that occur during periparturition and jeopardize immune defenses against mastitis-causing organisms. To better understand and control mastitis susceptibility in periparturient cows we need detailed understanding of the genes that regulate and orchestrate leukocyte development, trafficking, and immune defense against the bacteria that infected mammary glands and cause mastitis. We have begun to use combinations of DDRT-PCR, cDNA dot blots, and cDNA microarrays

to identify these genes in leukocytes. Using these techniques we have simultaneously monitored from a few to hundreds of expressed leukocyte genes for differential expression patterns during mid-lactation and periparturition. In this way, we have allowed the leukocytes to tell us their own story about disease susceptibility during periparturition by displaying and quantifying changes in global gene expression patterns. Further physiological studies of interesting differentially expressed genes will help us gain new knowledge about the behavior of gene expression during interesting scenarios such as parturition, intramammary infection, vaccination, and genetic selection. Results of these studies to date will be presented. It is hoped that the new knowledge generated from our work will enable targeted nutritional and drug studies focused on development of novel immunomodulators and mastitis preventatives and therapeutics for periparturient dairy cows. Identified genes will also be studied in our laboratory for the presence of harmful and beneficial mutations that could be taken advantage of using traditional genetic selection to improve mastitis resistance. If highly beneficial genes and alleles are identified, these could be used in the future to develop lines of transgenic cows whose mammary glands have been programmed to specifically target and eliminate intramammary infections. These genetic approaches to bolster immunocompetence should help us counteract any negative effects of selection for high milk yield on mammary immunity

Key Words: Functional Genomics, Periparturition, Mastitis

237 Genetics and Genomics of Susceptibility to Mycobacterial Infection in Cattle. P.M. Coussens^{*1}, B. Tooker¹, W. Nobis¹, and M.J. Coussens¹, *Michigan State University, East Lansing, MI 48824.*

The Mycobacteria are responsible for significant diseases in man and most animals. In cattle, Mycobacteria are responsible for Johne's dis-

ease (*M. paratuberculosis*) and bovine tuberculosis (*M. bovis*). As obligate intracellular bacteria, the Mycobacteria have devised ways of surviving in macrophages, one of the animals first lines of defense against such infections. The ability to survive in this hostile environment is a key step in the pathogenesis of Mycobacterial diseases. We have begun studies aimed at understanding interactions of Mycobacteria with the bovine macrophage, using both genetic and genomic tools. Clues from studies in mice and humans have been used to highlight possible genetic elements controlling susceptibility to Mycobacterial infection and to examine various bovine populations for genetic differences in these elements. One such element is the NRAMP 1 gene. In mice the NRAMP 1 gene is directly linked to susceptibility to infection by intracellular Mycobacteria. To evaluate potential roles of NRAMP 1 mutations in the outcome of mycobacterial infections in cattle, we have searched for polymorphisms within the bovine NRAMP 1 coding sequence and analyzed the bovine NRAMP 1 gene structure. These studies suggest that the NRAMP 1 gene is polymorphic in cattle and open the way for analysis of linkage to susceptibility to Mycobacterial infection. To better understand Mycobacterial survival in bovine macrophages, we have applied the tools of functional genomics, using a combination of DD RT-PCR and cDNA microarrays to identify key genes whose expression is altered upon macrophage uptake of Mycobacteria. Gene expression patterns have been cataloged into those genes whose expression is affected by the general process of phagocytosis and those genes whose expression appears to be specifically altered by uptake of Mycobacteria. Differentially expressed genes are then classified according to the deduced function or pathway to which their protein products belong. By this process, we hope to elucidate particular pathways within the normal course of macrophage activation that are adversely affected by Mycobacteria. Results of these studies to date will be presented and discussed.

Key Words: Functional Genomics, Mycobacteria, Johne's disease

Latest Development in On-Farm Ultrafiltration

238 Latest Development in On-Farm Ultrafiltration
1. History of On-Farm Ultrafiltration of Milk. John Bruhn^{*1},
¹*University of California, Davis.*

Research in the use of membrane processing of milk started in the early 1970's when dairy researchers saw a potential for this technology that was being used to make potable water from saltwater. At that time, the concentration of milk was possible, but problems with fouling, flux rates and difficulties with cleaning and sanitizing of the membrane kept it from being used in the dairy industry. In the early 1980's, the on farm use of reverse osmosis was explored. The farm milk was pasteurized before concentrating in a single pass unit. When the cheese plant received this concentrated milk, it was again pasteurized. The double pasteurization decreased cheese yields, but the on farm process was shown to work. In the 1990's, the on farm membrane processing was installed with a dairy producer cooperative in New Mexico. The concentrating process was evaluated extensively before the regulatory agencies would approve the use in grade A dairy foods. Research established that the concentrating process did not convey any special resistance to the pathogens in the raw milk to standard pasteurization. Nor did pathogens grow faster in the raw milk concentrate. No special resistances or growth advantages were noted. The operating parameters were also defined by the regulatory agencies. With the approval of the regulatory agencies, the membrane concentrated, raw milk became a marketplace reality. The raw milk concentrate is used to fortify solids in milk for cheese making. It also has application in the manufacture of frozen dairy desserts. It has potential for use in any dairy foods where a high quality, milk solid concentrate is needed. Potentially, it also could be used to make a grade A fluid milk product with the addition of water. The advantages of the raw milk concentrate to the dairy and food processor are just being realized.

Key Words: UF, RO

239 Regulatory Issues: Processing and Quality. Alfred Reeb, *New Mexico Department of Agriculture.*

Approximately 20 years ago, the dairy industry first proposed the on-farm ultrafiltration of milk. Initially, the regulatory concerns about the quality of raw milk, temperature of processing, and other processing conditions limited ultrafiltration of milk products to in-plant usage. When

on-farm ultrafiltration of unpasteurized milk was proposed in 1994, regulatory concerns about processing conditions and product quality were again expressed. The dairies, the membrane equipment supplier, and regulatory agencies worked together to arrive at an answer for the concerns on the processing conditions of the on-farm ultrafiltration and product quality of the retentate. These regulatory issues concerning the On-Farm Ultrafiltration of Unpasteurized Milk will be addressed in this presentation. Proper design of the Grade A Dairy Plant for Ultrafiltration of the milk was required. The review of the equipment included the monitoring and recording of the temperature of ultrafiltration processing. If the temperature during the ultrafiltration process was greater than 8 °C (45 °F), product was diverted through a flow diversion valve. Testing of equipment and the placement of regulatory seals will be discussed. Bacteriological quality of unpasteurized milk for concentration and unfiltered milk is in compliance with the Grade A Standard. Conformance of this concentrated product to Grade A Standards will be also discussed.

Key Words: Regulatory Issues, Quality of Unpasteurized UF Milk, Processing

240 Applications of membrane filtered cold milk as an ingredient. P. Tong^{*1} and H. Vyas¹, ¹*Dairy Products Technology Center, California Polytechnic State University, San Luis Obispo.*

Membrane processing of milk at low temperatures results in a concentrated and/or fractionated milk stream which has been obtained with little to no heating. Such concentrates can then be delivered to an ingredient user and only heat processed once to obtain the final pasteurized product. As a result, any undesirable changes associated with heat processing (e.g., protein denaturation, cooked flavors, etc.) can be minimized. When ultrafiltration membranes are used, modification in protein to lactose ratios, and mineral composition of the concentrate are possible. Therefore, such membrane processed milk concentrates will be desirable as ingredients for cheese manufacture, ice cream manufacture and specialized dairy based beverages and other foods. Use of these ingredients may improve finished product composition control (standardization to more optimum protein to fat or protein to lactose ratios), plant throughput/efficiency, and product overall quality (flavor, texture, etc.).

Key Words: ultrafiltration, membrane, milk

Hot Topics in Meat Processing

241 Developing Validation Models for E. Coli 0157 Inactivation in Dry Fermented Sausages. Shai Barbut* and Mansel Griffiths, ¹University of Guelph.

After the 1994 E. coli 0157:H7 outbreak associated with the consumption of semidried fermented sausage in Washington State, the USDA-FSIS has required processors to either validate their processes or include a step that will assure a 5 log reduction of the pathogen. The presentation will illustrate the work done in our laboratory to validate sausage fermentation (i.e., inoculated studies) for different commercial processes, and the initial development of three models to validate the process when the USDA-FSIS two log E. coli reduction option is chosen. The models include variables such as water activity, pH, fermentation and drying time, as well as the interactions among these variables. The predictive abilities of the models were confirmed by linear regression, comparing values for E. coli survival derived from the models with experimental values obtained from data that were not used to construct the models. Response surface diagrams were also produced to demonstrate the effects of the different variables.

Key Words: Fermented Sausage, E. Coli 0157, Validation models

242 Use of carbon monoxide in retail meat packaging. O. Sorheim*¹, H. Nissen¹, T. Aune², and T. Nesbakken³, ¹MATFORSK - Norwegian Food Research Institute, Aas, Norway, ²Norwegian School of Veterinary Science, Oslo, Norway, ³Norwegian Meat Research Centre, Oslo, Norway.

Centralised pre-packaging of fresh retail meat in modified atmospheres is common in many countries in Europe, but to a less extent in the USA. The predominating gas mixture for retail meat contains approx. 70 % O₂ and 30 % CO₂ enabling an extended, but still limited shelf life. Carbon monoxide (CO) binds strongly to myoglobin and maintains a bright red color of meat. The Norwegian meat industry has for 15 years been using a gas mixture of approx. 0.3 - 0.5 % CO, 60 - 70 % CO₂ and 30 - 40 % N₂ (CO mix). The market share of pre-packaged retail meat in the CO mix in Norway is 60 %. CO is presently not permitted for meat packaging in the EU or USA. However, CO is temporarily allowed in Norway, and an application for permanent use in the EU and Norway is under evaluation. Research on aspects of the CO mix has demonstrated several benefits. Consuming meat exposed to the CO mix does not pose a toxic hazard, because the meat contains only negligible amounts of CO. The CO mix is safe to use in meat plants, as the CO is delivered in a concentration of maximum 1 %. The combination of a stable, bright red color and a long microbiological shelf life of the meat is unique for the CO mix. The shelf life extension is achieved by the high CO₂ concentration and absence of O₂. Growth of *Yersinia enterocolitica*, *Listeria monocytogenes* and *Escherichia coli* O157:H7 was more inhibited by the CO mix than other packaging methods. Ground beef containing carboxymyoglobin required a higher temperature by cooking to develop a gray, well-done color than other forms of myoglobin. The main reason for resistance against CO relates to its ability to mask spoilage by color stabilization beyond the time of microbiological deterioration. A reliable shelf life of MAP meat can only be obtained through proper quality control of meat handling, packaging and chill chain.

Key Words: Carbon Monoxide, Packaging, Retail Meat

243 Use of the AMI Process Lethality Spreadsheet to Validate the Safety of Cooking Procedures. T. A. Freier*, Cargill.

Producers of cooked meat and poultry products are increasingly being required to produce documented, science-based validations of thermal processes. Traditional thermal death-time studies require relatively extensive laboratory facilities, time and expertise. When D and Z values are known (through experimentation or by obtaining published values), there remains the question of how to apply these variables to an actual thermal process. The American Meat Institute Foundation (AMIF) has sponsored the development of a process lethality spreadsheet that can

be used to estimate the effectiveness of specific heat processes in destroying microorganisms of concern. This model is readily available for downloading from the AMIF's web site. With the input of the proper variables, this spreadsheet can quickly indicate the total kill potential of a specific cooking process for any of the common food-borne pathogens of concern. This presentation will provide a practical introduction to the use of this model and will discuss the appropriate use of the data that is generated.

Key Words: Thermal Process, Computer Model, Critical Control Point Validation

244 Predictive models for growth of foodborne pathogenic spore-formers at temperatures applicable to cooling of cooked meat. Vijay Juneja*¹, ¹USDA-ARS-ERRC.

Inadequate cooling of foods in retail food operations is a major safety problem. Accordingly, the objectives of these studies were to determine a safe cooling rate for cooked beef and develop models to predict the germination, outgrowth and lag (GOL), and exponential growth rates (EGR) of *Clostridium perfringens* and *Clostridium botulinum* from spores. First, we demonstrated the effectiveness and validity of "square-root model" under non-isothermal conditions. Next, we developed two models, one each for *C. perfringens* and proteolytic *C. botulinum*, to predict their growth from spores at temperatures applicable to the cooling of cooked meat. It was found that for *C. perfringens*, the use of the logistic function provided a better prediction of relative growth than the use of the Gompertz function. For *C. botulinum*, growth curves were determined by fitting Gompertz functions to the data. From the parameters of the Gompertz or logistic function the growth characteristics, GOL times and EGR, were calculated. These growth characteristics were subsequently described by Ratkowsky functions using temperature as the independent variable. By applying multivariate statistical procedures, the standard errors and confidence intervals were computed on the predictions of relative growth for a given temperature. Closed form equations were developed that allow prediction of growth for a general cooling scenario. The predictive models should aid in evaluating the safety of cooked product after cooling and thus, with the disposition of products subject to cooling deviations.

Key Words: Predictive models, Spores, Cooling of cooked meat

245 Case ready red meat-demand and technology. Scott Eilert*¹, ¹Excel Corporation.

The demand for case ready red meat continues to grow at a pace unmatched in previous years. Suppliers of red meat are focusing a great deal of their growth around meeting these demands and providing solutions for retailers. The demand is being fueled by several factors, most notably the need to reduce labor and costs at the retail outlet. As the retail market is quite diverse (volumes, distribution methods, product lines, branding) so are the solutions that are required by retailers. There is no one ideal business or packaging model for case ready today. The proper solution for a retailer will vary with the factors listed previously. The goal of this presentation will be to present the various models of case ready, primarily focusing on the packaging formats that can be employed. Specifically, the various high oxygen and low oxygen formats will be presented. The advantages and disadvantages of each format will be discussed. In closing, this presentation will address key technological challenges as the industry moves to more central processing of red meat products for retail.

Key Words: Case Ready, Packaging, Read Meat

Developing and Sustaining International Agriculture Experiences in Animal Science Curricula

246 The nuts and bolts of student exchange programs. John C. Forrest*, Terry S. Stewart, Bud G. Harmon, and Michael H. Stitsworth, *Purdue University*.

Exchange programs prepare animal sciences students to participate in the emerging global economy. Purdue's successful international undergraduate exchange developed from a long history of international programs and faculty exchanges. Emphasis on student exchanges during the last decade stems from recognition that economic development of the agricultural sector depends upon a better understanding of the cultures that drive international trade. The first formal undergraduate animal agriculture exchange program developed out of a faculty sabbatical to Australia. Prior to that several animal sciences students participated in general agricultural exchange programs sponsored by International Programs in Agriculture.

Exchange programs that provide the most beneficial experiences for students are well organized by participating institutions. When possible equal numbers of students from each university should be recruited. A great economic deterrent to recruitment was overcome when university administrators allowed students to pay tuition to their home institution while participating in exchanges, and revenue remains constant for both institutions. Mentors with a strong interest in students and knowledge of the programs at the collaborating institution help programs go smoothly at both ends of an exchange. This is especially important in initial exchanges. When exchanges are ongoing, students tend to form networks between universities that are beneficial to new students.

Exchanges take many forms, from formal funded programs that generally include one full semester of courses at a host university, to summer work experiences. In some cases a work experience is either preceded or followed by a semester of resident instruction. Exchanges with developing countries generally require funding to allow students from those countries to participate, host families often help offset housing costs for students coming to the US, and provide cultural understanding beyond the normal university experience. Exchanges with developed countries are fostered by agreements that allow students to pay tuition at their home campus. Scholarships and other financial assistance are often provided to assist students with travel and extra expense of living in a foreign country.

Key Words: Student exchange programs, International exchange programs, International Animal Agriculture

247 The Linkage Project: a partnership in international educational development. M. D. Kenealy*, *Iowa State University, Ames*.

The Linkage Project was developed to create a model for US and international universities to align curricula to improve access to undergraduate and graduate programs for international students. The project proposal was driven by the need for increased globalization of education. If universities throughout the world are to capitalize fully on available knowledge and methodologies, they must prepare students who can move seamlessly through educational systems worldwide. Representatives of seven agriculture or veterinary medicine disciplines from Iowa State University (ISU) and National Agriculture University of Ukraine (NAUU)

partnered for a four-year effort funded by the United States Information Agency. Disciplines represented were: agricultural education, agricultural engineering, agronomy, animal science, economics, forestry, and veterinary medicine. Procedural steps were: 1. year one: one month exchanges of faculty counterpart teams from each discipline to study educational programs at the cooperating institutions and develop aligned bachelor of science (BS) programs; 2. year two: exchanges to finalize curricular proposals at ISU, open forums at NAUU to promote new BS programs to faculty and administration, and curricular implementation; 3. year three: on-site evaluation of the first year of implementation of BS programs and initiation of development of new master of science (MS) programs at NAUU; 4. year four: final adjustments and implementation of MS programs at NAUU. Faculty and students from the two universities involved in the Linkage Project benefited from accomplishment of the primary project objective of aligning curricula to enhance the process of student exchange, transfer, and graduate enrollment. Secondary benefits included internationalization of faculty and students, increased awareness of education on a global scale, and new opportunities for research partnerships. Additionally, the project positioned NAUU as a lead institution and model for preparing agricultural students for the changing economic system of the countries of the former Soviet Union.

Key Words: International, Curriculum

248 Developing/funding of exchanges of faculty and other international symposia related to teaching and research. J. F. Keown*¹, ¹*University of Nebraska, Lincoln, NE*.

The Institute of Agriculture and Natural Resources at the University of Nebraska is a member of the Mid America International Agricultural Consortium. This Consortium consists of the Agricultural Colleges located at the University of Missouri, Iowa State University, Kansas State University and Oklahoma State University. The main focus of this group is to work with Mexican Institutions to further research, teaching and extension with Mexican Universities, Governmental Research Centers, private industry and producer groups. The sole focus of this group is to work in the agricultural sectors of livestock and meats, biotechnology, wheat, maize, natural resources and current women's issues. This group has formed "sister university" relations with several Mexican Universities, held symposia in Mexico in the biotechnology, conservation tillage, exploring women's issues and by-product feeding. This consortium in previous years has spent considerable time and effort working overseas with USAID grants. With the reduction in USAID funding, the consortium took a different mode of action and decided to work mainly with Mexico. The Board of Directors, comprised of the Agricultural Deans at all five universities, changed due to the importance of the agricultural exports that flow to Mexico from this five-state region, as well as the increasing number of Mexican workers currently working in this five-state region in the meat packing, construction and general agricultural areas. The consortium feels that an exchange of scientific knowledge and of students and faculty will enhance economic development of both countries.

Key Words: MIAC, Mexico, Consortium

ADSA Dairy Foods: Dairy Products—Chemistry and Physical Properties

249 Methods to Prepare Glycomacropeptide from Cheese Whey. Takuo Nakano* and Lech Ozimek, *University of Alberta*.

Glycomacropeptide (GMP) found in cheese whey (or sweet whey) is a biologically active compound, and thought to be a potential ingredient for dietetic foods and pharmaceuticals. Thus, much attention has been given to the development of techniques to isolate and purify this glycopeptide. The objective of this study was to develop techniques to prepare GMP from sweet whey under a laboratory scale. We have developed the following techniques: 1) gel chromatography on Sephacryl S-200 in 0.1 M sodium acetate at pHs 7.0 and 3.5; 2) cetylpyridinium chloride treatment, and gel chromatography on Sephacryl S-200 in 0.1 M sodium acetate (associative condition) and on Sephadex G-75 in 6 M guanidinium chloride (dissociative condition); and 3) deproteinization with trichloroacetic acid and gel chromatography. In all the techniques

used, we obtained high purity GMP with amino acid composition having a trace (< 1 residue/ peptide) of phenylalanine (amino acid that does not occur in GMP). These techniques are useful to prepare GMP as a research chemical. The purified GMP may be used as a standard in chromatography and electrophoresis, and may also be used to test various known or unknown biological activities of this glycopeptide.

Key Words: Glycomacropeptide, Cheese whey, Purification

250 Scale up and mass balance of affinity purification of native β -lactoglobulin. Harit K. Vyas*, J. M. Izco, and R. Jimenez-Flores, *Dairy Products Technology Center, Cal Poly*.

The process of affinity purification of β -lactoglobulin in its native form using all-trans-retinal immobilized on Celite R-648TM was scaled up and applied to fractionate industrial sweet whey. Three different ways

of mixing the Celite R-648TM and whey for the interaction between all-trans-retinal and β -lactoglobulin were tried at pilot scale. The three methods used were (1) a continuous operation using a column packed with Celite R-648TM, (2) a batch operation in a stirred tank and (3) a continuous operation using a fluidized Celite R-648TM column. Adsorption and desorption of β -lactoglobulin were carried out at pH 5.1 and 7.0, using 0.01 and 0.1M phosphate buffers, respectively. The phosphate buffer containing desorbed β -lactoglobulin was concentrated 20 times using ultrafiltration and then freeze-dried. The packed column, stirred tank and fluidized column produced β -lactoglobulin with purity of 80, >95 and >95%, and recovery of 0.65, 2.88 and 2.88g per kg of Celite R-648TM, respectively. The comparative poor purity and recovery of β -lactoglobulin in the case of the packed column was attributed to insufficient contact between the passing fluids and the Celite R-648TM during adsorption, desorption and intermittent washing. The fluidized column method being a continuous operation with a gentle mixing action, was considered the best suited for further scale up to the industrial level.

Key Words: Process scale up, affinity purification, β -lactoglobulin

251 Separation of proteins from acid whey using clay minerals. J. Su and D. W. Everett*, *University of Otago, Dunedin, New Zealand.*

The adsorption and desorption behavior of whey proteins on clay minerals was investigated. Bentonite, halloysite, and kaolinite from New Zealand and eckalite from Australia were suspended in 1% (v/v) H₂O₂(aq) and stirred over a period of 6 days to oxidize organic surface impurities. To create a homoionic surface, minerals (except bentonite) were washed 4X in 1M NaCl at pH 2.6-3.0. Bentonite was washed 4X in 1M CaCl₂ at pH 2.6-3.0 to avoid mineral coagulation. All four mineral samples were then washed in deionized water until the conductivity approached that of the water. Acid whey (HCl, pH 4.6) was added to each clay sample in the ratio of 20:1 (v/w) for kaolinite, eckalite, and halloysite, and 10:1 (v/w) for bentonite. The pH was adjusted for each of eight samples of the four mineral-protein complex series in the range pH 3-10. Samples in triplicate were agitated for 60 min, centrifuged at 11,000 X g for 5 min at 4°C, and the supernatant examined for protein composition by SDS-PAGE and densitometry.

Proteins (α -LA, β -LG, and lactoferrin+BSA) were completely adsorbed up to pH 4 onto kaolinite, eckalite, and halloysite and up to pH 7 for bentonite, dropping to 10% adsorption onto kaolinite, 20-40% onto halloysite, 30-70% onto eckalite, and 60-95% onto bentonite at pH 10, the level of adsorption depending upon the protein. Adsorption of β -LG onto eckalite was significantly higher (70%), and significantly lower for α -LA onto bentonite (60%) compared to other proteins. Adsorption of 60kDa IgG was 100% complete over the range pH 3-10 on all four mineral surfaces. The level of desorption of bound proteins was measured by agitating for 60 min and washing the complexes in (1) distilled water, (2) 0.1, 0.2, 0.5, 1 and 2M NaCl, (3) 0.1% β -mercaptoethanol + 2M NaCl, (4) 6M urea, or (5) 6M urea + 2M NaCl. Washing the pH 3 complexes with solutions 1-3 did not result in any measurable protein desorption. Washing the pH 3 complexes with solution 4 resulted in 3-12% desorption of β -LG, and up to 25% desorption of β -LG in solution 5 from all clays. Desorption of other proteins was not detectable. Clay minerals may afford an inexpensive method to isolate β -LG from acid whey.

Key Words: Clay Minerals, Whey Proteins

252 Effect of β -casein addition on MFGM-stabilized soy oil emulsions. K. Hutchby and Everett D. W.*, *University of Otago, Dunedin, New Zealand.*

The binding and aggregating effects of β -CN addition to soy oil emulsions coated with milk fat globule membrane (MFGM) material were examined. Raw cream was phase-inverted and buttermilk collected. Casein micelles were dissociated by citrate addition and the MFGM recovered by centrifugation at 100,000×g for 50 min at 15°C followed by freeze drying. MFGM-stabilized soy oil emulsions (1% MFGM, 10% soy oil, w/w) were prepared using a MicrofluidizerTM (40 passes) at an effective outlet pressure of 75 MPa. Globule diameter was determined by photon correlation spectroscopy at pH 4.8 to 5.8 in 0.2 unit increments in a 20 mM sodium acetate buffer, and at pH 7.0 in a 20 mM Tris-HCl buffer, before and after β -CN addition. Emulsion dilution factor was 1 μ L per 2 mL of filtered buffer. Ten measurements were made every 5 min for duplicate samples.

Hydrodynamic diameter was 600±50 nm at pH 7 and remained in the range 550-725 nm down to pH 5.4. Below this pH the diameter increased, rising to 1060±175 nm at pH 4.8. Addition of β -CN reduced the diameter within a 5 min period, the greatest decrease at pH 5.2 from 725±150 to 150±30 nm. Decreases in diameter at the pH extremes was of order 100 nm. Trypsin (3 μ L of 0.01 g/mL in 20 mM Tris-HCl at pH 7) was added to the MFGM-stabilized globule and to the emulsion after β -CN addition, both at pH 5.2. There was no effect on diameter when β -CN was not previously added. The diameter increased from 160 to 330 nm over a 15 min period after β -CN addition, followed by a rapid increase to 1100 nm over 5 min after trypsin addition, indicating extensive aggregation after the initial dispersing. Emulsions stabilized with MFGM aggregated over the pH range 4.8 to 7.0, with more loose and extensive aggregates forming at pH 4.8 nearer the pI of MFGM. β -CN may bind to the MFGM surface and disperse the aggregates by a steric stabilization mechanism. Hydrolysis of the hydrophilic flexible "tail" of β -CN by trypsin caused the globules to aggregate again. These results show that it is feasible to disperse a food emulsion coated with MFGM using β -CN. In addition, it is likely that fat globules in cheese interact with the β -CN of the casein matrix, holding the globules into place.

Key Words: Emulsions, Casein, Photon Correlation Spectroscopy

253 Characterization of dephosphorylated β -Casein. F. Haidari*, L.E. Metzger, and D.E. Smith, *University of Minnesota, St. Paul, MN.*

A method for isolation of β -casein, developed at the University of Minnesota, has allowed access to large quantities of purified β -casein. In this research, β -casein was isolated using the aforementioned method and then dephosphorylated utilizing a known method for dephosphorylation of caseins with slight modification. In this procedure, β -casein is enzymatically dephosphorylated with potato acid phosphatase (28 units per 1 g protein) for 72 hours at pH 7 at 4°C. The reaction takes place in a dialysis tube (12400 M.W. cutoff) against water which removes free phosphates that inhibit the enzyme activity. The protein solution is heated to 85°C to inactivate the enzyme and then lyophilized. This experiment was repeated with three separate lots of isolated β -casein. The degree of dephosphorylation was confirmed by ³¹P-NMR spectroscopy, inductively coupled plasma spectroscopy, and fast protein liquid chromatography. The results indicated that the extent of dephosphorylation was more than 90 percent. The dephosphorylated β -casein was further purified with anion exchange chromatography. The secondary structure of the highly purified dephosphorylated β -casein was studied and compared to that of the native β -casein by utilizing FT-IR spectroscopy. Furthermore, the calcium binding ability of the dephosphorylated β -casein was measured against varying concentrations of calcium solution.

Key Words: β -Casein, Dephosphorylation, Characterization

254 Effects of added plasmin on the rheological properties of rennet-induced skim milk gels. M Srinivasan* and J.A. Lucey, *University of Wisconsin-Madison*.

Elevated activity of plasmin enzyme (EC 3.4.21.7) results in reduced cheese yields and texture defects and this can occur in mastitic and late-lactation milks. The effects of exogenous plasmin on the rheological properties, at small and large deformations, of rennet-induced skim milk gels were studied. Rennet gels were made from 9% (w/w) NFDM, which was reconstituted for 3 h at 32°C. Porcine plasmin (0.01 mg/ml milk) was added to milk and samples incubated for 1, 2, 3, 4, 6 and 8 h at 37°C. The reaction was terminated using soy bean trypsin inhibitor. Samples with no added plasmin were also incubated (controls). Extent of degradation of caseins was determined by SDS-PAGE. Gelation properties were determined at 32°C using dynamic low amplitude oscillation and rheological parameters were monitored for a period of 6 h after rennet addition. Extent of breakdown of α_s - and β -caseins increased with incubation time with plasmin. After 8 h of incubation, the amounts of intact α_s - and β -casein were 24.30.5 and 13.60.3%, respectively. Rennet gels made from milk with no added plasmin had storage moduli of 751 Pa. Storage moduli of rennet gels decreased with increasing degradation of caseins. After incubation of milk with plasmin for 8 h, storage moduli decreased to 102 Pa. Loss tangent values of rennet-induced gels after 8 h incubation increased to 0.61 from 0.35 in control milk, indicating a more liquid-like gel character. In contrast to previous studies, we found that storage moduli of gels decreased even when a small amount of breakdown of caseins occurred, e.g. after 1 h incubation with plasmin the amounts of intact α_s - and β -caseins were 84 and 80%, respectively, and this resulted in 20% reduction in the storage modulus. Gelation time hardly changed until 3 h of incubation, thereafter gelation time increased considerably. Fracture properties were determined by subjecting the gels to a low shear rate (0.01 s^{-1}). Fracture stress (force required for fracture) of gels decreased with increasing casein breakdown and after 8 h incubation with plasmin the fracture stress was only 103 Pa, whereas control milk was 786 Pa. Low levels of plasmin activity influences the texture of rennet gels which could have significant effects on the yield and texture of cheese.

Key Words: Plasmin, Rennet coagulation, Rheology

255 Effect of Homogenization Pressure and Selected Additives on Particle Size Properties of Retort Sterilized Dairy Beverages During Storage. C. Lin* and R. Richter, *Texas A&M University, College Station, TX*.

The objective of this study was to determine the effect of homogenization pressure and six mineral salts and hydrocolloids on the particle size properties of dairy beverage processed in a retort. Skim milk, cream, nonfat dry milk, and sucrose were mixed to make beverages containing either 0.1% sodium salts (sodium citrate, sodium tripolyphosphate, or sodium hexametaphosphate), 0.05% hydrocolloids (locust bean gum, iota-carrageenan, or kappa-carrageenan), or combinations of the salts and hydrocolloids. The mixtures were heated, homogenized at either 20, 50, or 90 MPa, canned, and sterilized with a retort at 121°C for 6 min. The processed products were stored at 36°C and tested after 1, 10, 20, and 30 days of storage. Particle size distribution of the sample was determined with a Coulter LS130 particle size analyzer. Particle size index was calculated as the ratio of mean particle size (D(4,3)) of the top and bottom layers. Both mineral salts and hydrocolloids significantly affected particle size index. Samples containing sodium tripolyphosphate or iota-carrageenan had the particle size index values closest to 1.00 but samples that contained sodium citrate or locust bean gum had the smallest mean particle size. Nevertheless, samples that contained both sodium tripolyphosphate and kappa-carrageenan had a better particle size index than samples that contained sodium tripolyphosphate and iota-carrageenan. The mean particle size decreased as the homogenization pressure was increased. This effect became more apparent as storage time increased. The mean particle size increased as storage time increased for samples homogenized at 20 MPa but did not change significantly in samples homogenized at 90 MPa.

Key Words: Homogenization Pressure, Hydrocolloids, Particle Size

256 The Effect of Stabilizers and Emulsifiers on the Rheological Properties of Ice Cream Model Systems. J.V. Patmore* and H.D. Goff, *University of Guelph, Guelph, Canada*.

Ice cream contains many ingredients that influence quality of the final product. Locust bean gum (LBG) and guar gum (GG) are two stabilizers used in ice cream to modify texture and enhance shelf life. Emulsifiers help create ice cream structure because they form a thin interface around fat globules, which allows fat to partially coalesce during whipping. During homogenization and aging, emulsifiers adsorb to the fat globule surface, displacing milk proteins and thus leaving more proteins in the aqueous phase. The purpose of this research was to determine the rheological properties of model ice cream mixes to understand how different ingredients affect aqueous structure formation during freezing, and ultimately ice crystal growth during ice cream storage. A controlled stress rheometer measured yield stress and frequency sweeps for solutions comprised of skim milk powder (SMP) (4% protein), sucrose (10%) and LBG or GG (0.25%), with or without fat (10%) and emulsifier (0.1%). Measurements were made at -1°C after being quiescently frozen and temperature cycled (-15°C to -1°C to -15°C) for a total of five cycles. Rheological data showed that LBG/SMP/sucrose solutions developed a more elastic network during temperature cycling, as shown by significantly increasing yield stress and decreasing $\tan \delta$ values ($P \leq 0.05$), while GG/SMP/sucrose solutions did not. Emulsifiers enhanced solution rigidity after temperature cycles. Junctions form more easily between LBG molecules than GG molecules because of their structures, which may explain why LBG forms weak networks during temperature cycling. When LBG or GG are mixed with milk proteins, concentrations of both stabilizer and protein increase because LBG and GG are thermodynamically incompatible with milk proteins. This effect is further enhanced when water is frozen out of solutions at subzero temperatures or when protein concentration in solution is increased. The above evidence suggests that freezing and phase separation with milk proteins enhances the ability of LBG to form weak networks, which may explain why LBG has been shown to slow down recrystallization rates better than GG.

Key Words: stabilizer, emulsifier, rheology

257 Measurement of temperature dependent changes in process cheese viscosity. L. E. Metzger* and M. L. Leman, *University of Minnesota, St. Paul, MN*.

A ten-minute test which measures temperature dependent changes in the viscosity of process cheese was developed utilizing a rapid visco analyzer (Newport Scientific, Warriewood, Australia). The rapid visco analyzer is capable of adjusting sample temperature between 0 and 99°C with stirring speeds of 0 to 2000 rpm and measures viscosity from 50 to 50,000 cps. During the test the sample is heated to a set temperature in five min, held for three min, and cooled to a set temperature in 2 min. The sample is stirred from four minutes until the end of the test. The initial hot viscosity, time at minimum viscosity, change in viscosity during holding at maximum temperature and change in viscosity during cooling were determined. Three commercial samples (14 g cheese and 1 g propylene glycol) were evaluated in triplicate utilizing a variety of operating conditions including stirring speeds of 100, 200, and 300 rpm, maximum temperatures of 80, 85, and 90°C and cooling temperatures of 65, 70, and 75°C. Initial hot viscosity, change in viscosity during holding at maximum temperature, and change in viscosity during cooling were significantly ($p \leq .05$) affected by stirring speed, maximum temperature, and cooling temperature. Suggested operating conditions are heating from 25 to 85°C in five min, holding for 3 min, and cooling to 65°C in two min with a stirring speed of 200 rpm. Under these operating conditions significant ($p \leq .05$) differences in initial hot viscosity, change in viscosity during holding at maximum temperature, and change in viscosity during cooling were observed between the three samples. The rapid visco analyzer can be used to measure temperature dependent changes in viscosity of process cheese and has potential as a quality control technique.

Key Words: process cheese, viscosity

258 On-farm factors influencing the tenderness of pasture-fed beef raised commercially in New Zealand. B.C. Thomson*, K.V. Gilbert, and N.J. Simmons, *AgResearch Limited, Hamilton, New Zealand.*

This survey aimed to identify the amount and factors contributing to the variation in tenderness of strip loins from New Zealand beef animals. Strip loins (longissimus dorsi) were collected 24 hours post-slaughter from 10 beef animals from four abattoirs every fortnight over the killing season for a year (n=740). Producers were asked about the history of their animals. Shear force was determined 2 and 7 days post-slaughter in samples cooked to an internal temperature of 75°C in a boiling water bath, using a MIRINZ tenderometer. The influences of the different variables were analysed and the least square means presented. Although, there was a wide range of tenderness values (1.5 to 16.6 kgF 7 days post-slaughter), 91% of the samples were below 8 kgF 7 days post-slaughter. Possible reasons for the variation were examined. There was a strong seasonal effect on tenderness 2 days post-slaughter; samples in the spring were tougher than those in summer, winter and fall (8.7, 8.2, 8.0 and 7.2 kgF respectively, $P < 0.009$), this effect was reduced by day 7 of storage. This effect appeared to be at least partially due to the producer's perception of weather conditions immediately prior to slaughter; animals that were slaughtered when the weather was classified as colder than normal for the period were tougher than when it was warmer, hotter or normal (9.5, 8.6, 7.1 and 6.0 respectively, $P < 0.03$). Heifers were tougher than steers at both time points (9.1 vs 6.5 and 6.4 vs 5.0 kgF for 2 and 7 days post-slaughter respectively, $P < 0.005$), an effect unrelated to ultimate pH (5.56 vs 5.61 for heifers and steers respectively, $P < 0.30$). Poor growth rates as classified by the producer, buying from the saleyard vs buying direct from another producer, and low levels of contact with humans also reduced tenderness, but the effects were smaller. The identification of key factors like the above, will allow the development of appropriate measures for handling animals and carcasses of different backgrounds on-farm and during processing to reduce the variation in the tenderness of the final product. Work is currently underway to examine the effects of factors immediately prior to slaughter.

Key Words: Tenderness, Sex, Season

259 National Beef Quality Audit-2000: Survey of producers, packers, and end-users. D. L. Roeber*¹, D. R. McKenna², P. K. Bates³, T. B. Schmidt⁴, K. E. Belk¹, J. W. Savell², J. B. Morgan³, T. H. Montgomery⁴, and G. C. Smith¹, ¹Colorado State University, Fort Collins, CO, ²Texas A & M University, College Station, TX, ³Oklahoma State University, Stillwater, OK, ⁴West Texas A & M University, Canyon, TX.

National Beef Quality Audits (NBQA) in 1991 & 1995 provided benchmark data on quality challenges for the beef industry. Face-to-face interviews in 1991 & 1995 identified hide defects and lack of uniformity in live cattle as leading quality challenges for packers, and external fat and low overall uniformity and consistency as leading quality challenges for purveyors, retailers, and restaurateurs. For NBQA-2000, face-to-face interviews were replaced with questionnaires to solicit opinions of seedstock generators, cow-calf producers, stockers/backgrounders, and feedlot operators and to increase data collected from packers, purveyors, retailers, and restaurateurs. The most frequently cited ($P < 0.05$) management changes made since 1991 in the seedstock and cow-calf sectors (n = 2,308) were improved genetics using EPDs, changed injection-site location, and improved genetics using physical characterization. The most frequently cited ($P < 0.05$) management changes in the stocker/backgrounder and feeder sectors (n = 740) were changed injection-site location, improved handling, and changed genetic types of cattle. Identified changes coincided with those quality challenges for which packers (n = 29) and end-users (n = 113) have seen the greatest improvement. Seedstock and cow-calf producers said results of the previous audits had a "strong" (18.7%) or "moderate" (57.6%) impact on changes in beef quality since 1991; comparable responses were, for stocker/backgrounders plus feedlot operators (15.3% or 62.7%), for packers (6.9% or 55.2%), and for end-users (9.5% or 71.8%). Aggregated responses of the production sectors revealed the greatest quality challenges facing the beef industry were lack of uniformity in live cattle, inadequate tenderness, and insufficient marbling in carcasses and cuts. Aggregated responses of end-users revealed that the greatest quality challenges for the beef industry were insufficient marbling, lack of

uniformity in cuts, and inadequate tenderness. These findings should be useful to the beef industry and those who provide educational and research services in seeing where progress has been made and challenges still exist.

Key Words: Beef quality, Market survey

260 National Beef Quality Audit-2000: Results of slaughter floor assessments. P.K. Bates*¹, D.R. McKenna², D.L. Roeber³, T.B. Schmidt⁴, J.B. Morgan¹, J.W. Savell², T.H. Montgomery⁴, D.B. Griffin², D.S. Hale², and G.C. Smith³, ¹Oklahoma State University, ²Texas A&M University, ³Colorado State University, ⁴West Texas A&M University.

In order for the beef industry to improve quality and consistency of beef, the current state of the industry must be assessed. The National Beef Quality Audit-2000 was conducted as a sequel to previous audits in 1991 and 1995. Plants (n = 30) were audited from May to November 2000. Each university team (n = 4) surveyed seven or eight plants for the equivalent of one day's production. Fifty percent of each lot was audited in each plant resulting in a total sample size of 43,415 carcasses for hide-on and 43,595 carcasses for bruise evaluations. For condemnation data, approximately 10% of each lot was sampled, resulting in a total sample size of 8,588. Slaughter floor data was segmented into three categories: hide-on, bruise, and condemnation. Hide-on data consisted of evaluations of hide color, mud/manure characteristics, horns, and brands. Bruise data consisted of the frequency, location, and severity of bruises. Offal and carcasses were evaluated for the incidence of condemnation. Data indicated that 45.1% of cattle were predominately black hided, 31.0% were red and 8.0% were yellow. Of the cattle surveyed, 18.0% had no mud/manure, while 55.8% had a small amount. The frequency of cattle without horns was 77.3%. Data revealed 49.3% of the cattle were not branded, 46.2% had one brand, and 4.4% had multiple brands. Of the cattle surveyed, 36.3%, 13.7%, 3.6% had brands located on the butt, side and shoulder, respectively. Data indicated that 53.3% of cattle had no bruising, while 30.9% had one bruise and 15.8% had multiple bruises. Of the cattle with bruises, 14.9%, 25.9%, 19.4%, 28.2%, and 11.6% were located on the round, loin, rib, chuck and brisket, flank and plate, respectively. Offal and carcasses were evaluated for the incidence of condemnation and corresponding reasoning for condemnation. Head, tongue, liver, lung, tripe, and carcass condemnations were 30.3%, 13.8%, 11.6%, 6.2%, 7.0% and 0.1%, respectively. Results from the slaughter floor assessment indicate quality and consistency improvements have been made in the fed-beef cattle industry since previous the audits.

Key Words: Beef Quality, Slaughter, Market Surveys

261 National Beef Quality Audit-2000: Results of carcass assessments. D.R. McKenna*¹, P.K. Bates², D.L. Roeber³, T.B. Schmidt⁴, D.S. Hale¹, D.B. Griffin¹, J.W. Savell¹, J.B. Morgan², T.H. Montgomery⁴, and G.C. Smith³, ¹Texas A&M University, College Station, TX, ²Oklahoma State University, Stillwater, OK, ³Colorado State University, Ft. Collins, CO, ⁴West Texas A&M University, Canyon, TX.

The National Beef Quality Audit-2000 was conducted to assess the current status of the quality and consistency of the U.S. fed steer and heifer population. Previous audits, conducted in 1991 and 1995, have been used as a baseline to pinpoint inadequacies and problems that the industry needs to improve upon. Plants (n = 30) were audited during a seven-month period (May to November, 2000). Each university team (n = 4) surveyed seven or eight plants for the equivalent of one day's production. Ten percent of each lot for each shift was audited in each plant, resulting in a total sample size of 9,396 carcasses. USDA grade factors and other data were collected in the cooler. Mean (SD) USDA yield grade traits were as follows: USDA yield grade, 3.0 (0.87); carcass weight, 356.9 (42.7) kg; adjusted fat thickness, 1.24 (0.53) cm; longissimus muscle area, 84.5 (10.8) cm²; and kidney, pelvic, and heart fat, 2.35 (0.76) %. The distribution of USDA yield grades were as follows: yield grade 1, 12.2%; yield grade 2, 37.4%; yield grade 3, 38.6%; yield grade 4, 10.4%; and yield grade 5, 1.3%. Carcasses weighing over 431 kg were 3.9% and carcasses having ribeyes greater than or equal to 96.8 cm² were 13.2% of the carcasses surveyed, respectively. Mean (SD) USDA quality grade traits were as follows: USDA quality grade, Select⁸⁵ (60.6);

marbling score, Small²³ (101.0); overall maturity, A⁶⁶ (23.8); lean maturity, A⁶⁴ (19.9); and skeletal maturity, A⁶⁷ (30.5). The distribution of USDA quality grades were as follows: Prime, 2.0%; Choice, 49.1%; Select, 42.3%; Standard, 5.6%; and Commercial, Utility, Cutter, and Canner, 0.9%. The incidence rates of dark cutters, blood splash, and yellow fat were 2.3%, 0.5%, and 0.4%, respectively. B-maturity carcasses were 2.5%, and C-maturity and older carcasses were 0.9% of the population surveyed. Steers were 67.9%, heifers 31.4%, and bullocks 0.3% of the fed-beef population evaluated. Results indicate a trend toward heavier carcass weights and larger ribeyes, however, other yield grade factors, and quality grade factors were similar to previous audits.

Key Words: Beef quality, Meat grades, Market surveys

262 National Beef Quality Audit-2000: Consensus of the beef industry. T. B. Schmidt¹, D. L. Roeber², P. K. Bates³, D. R. McKenna⁴, T. G. Field², T. H. Montgomery¹, J. B. Morgan³, J. W. Savell⁴, and G. C. Smith², ¹West Texas A & M University, Canyon, TX, ²Colorado State University, Fort Collins, CO, ³Oklahoma State University, Stillwater, OK, ⁴Texas A & M University, College State, TX.

Representatives of the beef industry, as participants in the Strategy Workshop of the National Beef Quality Audit-2000 (NBQA-2000), reached consensus regarding the leading quality challenges for the industry. Participants (n = 40) included seedstock generators, cow-calf producers, stockers/backgrounders, feedlot operators, packers, purveyors, restaurateurs, retailers, and academicians. Participants ranked the top ten quality challenges, by severity of the problem for the industry, based upon results of questionnaires and in-plant audits. Severity of quality challenges was determined on an 11-point scale (-5 = severe problem, +5 = above expectations). Leading quality challenges were (1) low overall uniformity and consistency of cattle, carcasses, and cuts (-3.0 ± 0.5); (2) inappropriate carcass size and weight (-2.9 ± 0.2); (3) inadequate tenderness of beef (-2.2 ± 0.3); (4) insufficient marbling (-2.0 ± 0.4); and (5) reduced Quality Grade and tenderness due to growth-promoting implants (-2.0 ± 0.3); all different from zero (P < 0.05). Participants developed strategies, tactics, and goals to overcome quality shortfalls by 2005. Goals included (1) eliminate USDA Standard carcasses, (2) eliminate USDA Yield Grade 4 and 5 carcasses, (3) eliminate injection-site lesions from whole muscle cuts, including the chuck, (4) eliminate side brands, (5) reduce horns to less than 5% of fed cattle supply, (6) develop and implement a standardized electronic identification system, (7) develop information systems that allow producers to conduct a quality audit of their own herd, (8) eliminate major and critical bruises that result in subprimal devaluation, (9) improve transportation, (10) market seedstock animals with meaningful genetic data for production and end-product traits, (11) train all producers in Beef Quality Assurance, and (12) continually improve the eating quality of beef. Beef producers can begin to recapture a portion of the \$100.10 (Waste = \$50.96, Taste = \$24.45, Management = \$18.23, Weight = \$6.46) in quality losses per fed steer/heifer harvested if they develop, implement, and manage cattle using a total quality management approach.

Key Words: Beef quality, Market survey

263 Incidence of injection-site lesions in top sirloin butts of fed steers and heifers. D. L. Roeber¹, R. C. Cannell², K. E. Belk¹, J. N. Sofos¹, J. A. Scanga¹, G. L. Cowman³, and G. C. Smith¹, ¹Colorado State University, Fort Collins, CO, ²ConAgra Beef Company, Omaha, NE, ³National Cattlemen's Beef Association, Englewood, CO.

Damaged beef muscle tissue resulting from intramuscular injections of animal-health products represents a "quality control" problem and an economic loss to the beef industry. Injection-site lesion audits commenced in 1990 when the incidence was documented to be 21.6%. Such lesions are unsightly and the wound-healing process causes toughening of muscle in a radius of 7.6 cm around the injection-site. Fifteen individual and sequential national audits of injection-site lesions in beef top sirloin butts were conducted at the steak provisioner/cutting level between November 1995 and July 2000. The national incidence of injection-site lesions in the top sirloin butts audited (n = 240,080) decreased (P < 0.05) between November 1995 (11.4%) and July 2000 (2.1%). From November 1995 to July 1997, mean injection-site lesion weight, across all lesion classes, increased (P < 0.05) from 192.5 g to 435.8 g, respectively; mean lesion weight subsequently decreased (P < 0.05) to 249.8 g in July

2000, but was still heavier (P < 0.05) than in November 1995. The increase from 1995 to 1997 coincided with a response by steak cutters to the release of data confirming the "toughening response" in tissues surrounding injection-site lesions. Results of these audits indicate that producers have changed injection practices; probably due to the efforts of the National Cattlemen's Beef Association and state beef quality assurance programs to heighten awareness of the injection-site lesion issue. Analyses of results for lesion classes, partitioning lesions according to chronological stages of the healing process, suggested that the majority of lesions were induced at times which coincide with cow-calf, stocker, or early finishing-period stages of cattle production.

Key Words: Injection-site lesion, Top sirloin butt, Incidence

264 Incidence of injection-site lesions in beef and dairy cow rounds. D. L. Roeber¹, R. C. Cannell², K. E. Belk¹, J. A. Scanga¹, J. N. Sofos¹, G. L. Cowman³, and G. C. Smith¹, ¹Colorado State University, Fort Collins, Co, ²ConAgra Beef Company, Omaha, NE, ³National Cattlemen's Beef Association, Englewood, CO.

While incidence of injection-site lesions in top sirloin butts and rounds in fed cattle has been well documented, incidence and severity of lesions in rounds of beef and dairy cows has not been reported. This study determined incidence and type of injection-site lesions in beef and dairy cow rounds. Audits were conducted in 1998, 1999, and 2000 on 3,190 gooseneck rounds (beef: n = 1,695; dairy: n = 1,495) in seven states. Rounds were cut into 1.25-cm slices to determine the number of lesions present and the type of lesion. In 1998, 31.1% of beef rounds and 60.1% of dairy rounds had an injection-site lesion. The frequency of lesions in beef rounds declined (P < 0.05) nearly 6 percentage points between 1998 and 1999 and an additional 6 percentage points between 1999 and 2000 (P < 0.05). The frequency of lesions in dairy rounds did not change (P > 0.05) from 1998 (60.1%) to 1999 (51.0%). However, the incidence in dairy rounds declined (P < 0.05) over 16 percentage points between 1999 and 2000. In 1998, 1999, and 2000 the incidence in beef rounds was lower (P < 0.05) than the incidence in dairy rounds. In all rounds, 95.2% and 89.0%, of all lesions were clear lesions (older lesions comprised primarily of connective tissue) or woody calluses (infiltrated with connective tissue and fat), respectively. Incidence of clear lesions and woody calluses in beef and dairy rounds in 1998, 1999, and 2000 was higher (P < 0.05) than incidence of cystic, nodular, or metallic lesions. However, still of concern were the 4.8%, 3.3%, and 4.1% of cystic lesions (encapsulated lesions containing fluid) that were found in beef rounds in 1998, 1999, and 2000, respectively, and the 4.1%, 2.3%, and 2.2% of cystic lesions that were found in dairy rounds in 1998, 1999, and 2000, respectively. Incidence of cystic lesions in beef vs. dairy rounds did not differ (P > 0.05). Monitoring of the incidence of injection-site lesions in beef and dairy rounds allows educational efforts of state and national BQA programs to target, more definitively, management practices of producers that can minimize occurrence of such defects in end-products.

Key Words: Injection-site lesion, beef and dairy rounds, tissue damage

265 Bison grain fed and grass fed top loin taste test. J. L. Lanier¹, C. D. Smith¹, P. Chapman², and T. Grandin³, ¹Lanier Animal Systems, ²Dept. of Statistics, Colorado State University, ³Grandin Livestock Handling Systems, Ltd..

A study was conducted to determine consumer preference/acceptance for grass-fed and grain-fed bison steaks. Twenty-five top loin steaks, (longissimus lumborum) from each treatment group (grass-fed or grain-fed; 6 producers each treatment), were cooked to an internal temperature of 60°C. Warner-Bratzler shear force values were determined on 21 steaks (10 grass-fed, 11 grain-fed). Customers (n=144; 53% women) of two Alfalfa's Market in northern Colorado participated in an "untrained consumer taste panel" to evaluate overall like or dislike, flavor, tenderness, and juiciness. Ninety percent of the panelists were Caucasians and the average age was late 30's. Contribution to health was the primary factor in choosing products for a main meal, while taste was the primary factor for a special meal ingredients. Interest in purchasing bison meat to be cooked at home was slightly greater than ordering bison meat at a restaurant. Sixty-two percent of the panelists would prefer to purchase grass-fed bison steaks rather than grain-fed steaks, with the most frequent reason given as "grass-fed are more natural". Grain-fed steaks had a greater acceptance rating for flavor (P<.01) adjusted for thickness of the steak and income of the panelist, and overall

acceptance ($P=.02$), adjusted for thickness. There was evidence of variability among animals from different producers within both feed-types for tenderness (est. $\sigma = .075$; glm test $P=.02$), and juiciness (est. $\sigma = .017$; glm test $P=.02$). A lack of consistency within grass-fed and grain-fed producers for juiciness and tenderness ($P=.02$), as well as marginal consistency for flavor and overall acceptability within feed-types was found. Thicker grain-fed steaks had a higher probability of preference ($P=.02$) than thinner grain-fed steaks. Thickness was not a condition of acceptance for grass-fed steaks. If a customer was male, the odds of not preferring grass-fed steak decreased by a multiple of .471 ($P=.03$). Mechanical analysis of tenderness found all bison loin steaks grilled to an internal temperature of 60°C to be tender, with no difference between feed-types.

Key Words: Bison, Consumer taste test, Meat

266 Influence of feeding malting industry byproducts to feedlot cattle on longissimus muscle sensory traits and tenderness. C. R. Dahlen*¹, K. Hachmeister⁴, C. M. Zehnder¹, M. Dikeman⁴, G. C. Lamb³, L. R. Miller¹, H. Chester-Jones², and A. DiCostanzo¹, ¹University of Minnesota, St. Paul, ²Southern Research and Outreach Center, Waseca, ³North Central Research and Outreach Center, Grand Rapids, ⁴Kansas State University, Manhattan.

Loins from 48 crossbred steers were used to evaluate effects of feeding malting industry byproducts (MBP) on sensory traits, color, and Warner-Bratzler (WB) shear force. Pens (two heavy and two light replicates; 5 steers/pen) were allocated to receive one of four dietary treatments consisting of a corn grain-based diet (Control) where corn gluten feed (CGF), MBP, or MBP and thin stillage (MBPTS) substituted for a portion of corn silage and/or corn. Steers in heavy or light replicates were harvested after 110 or 138 d on feed, respectively; 97 d after receiving a single steroid implant. Loins were aged at 2 C for 14 d postmortem, cut into steaks (2.54 cm thick) and analyzed for WB shear force, sensory, and color evaluation. Neither cooking loss nor WB shear force were affected ($P > .05$) by treatment. Steaks from steers fed CGF had more desirable scores for myofibrillar tenderness than those from steers fed Control ($P = .004$) or MBPTS ($P = .08$). A similar trend ($P = .06$) was observed for overall tenderness. Steaks were found to be moderately juicy and intense in flavor, with practically no connective tissue or off-flavors regardless of treatment ($P > .05$). Steaks from steers fed MBPTS tended ($P = .06$) to be redder (higher 630/580 ratios) during display than those from CGF steers, whereas steaks from steers fed Control tended ($P = .06$) to be darker (lower L* values) than those from MBPTS steers. Steaks from steers fed CGF tended ($P = .07$) to be less red (lower a* values) than those fed Control, and less red ($P < .05$) than steaks from steers fed MBPTS. Feeding steers MBP had no adverse effects on longissimus muscle tenderness or sensory traits.

Key Words: Tenderness, Beef, Byproducts

267 Tenderness improvement through prerigor muscle stretching of Holstein cow carcasses. J.R. Claus¹, H. Wang², and N.G. Marriott*², ¹University of Wisconsin-Madison, ²Virginia Polytechnic Institute and State University.

The objective was to determine if prerigor muscle stretching would improve the tenderness of beef from Holstein cow carcasses. In a commercial packing plant, carcasses were suspended in the common vertical position and nine carcasses (approx. 365 kg each) were selected, with one side randomly designated for the Tendercut treatment (TC) with the counterpart as a control (C). After 35 min postmortem, the 12th thoracic vertebra, Multifidus dorsi, and connective tissues of the TC sides were completely severed, leaving only the Longissimus muscle (LM) intact in this area. Both sides were chilled in a cooler that utilized spray chilling at 4 C for 24 h. The LM between the 2nd lumbar and 9th thoracic vertebrae was removed, vacuum packaged, and aged for 10 days (4 C). After aging, samples were frozen and stored (-31 C). The LM was cut into 25.4 mm steaks. Steaks were thawed and cooked to an internal temperature of 70 C. The LM of TC treated carcasses had longer ($P<0.05$) sarcomeres than the C samples in both the anterior (2.55 vs. 1.70 μm) and posterior regions (2.13 vs. 1.62 μm). In the anterior portion of the LM, the Warner-Bratzler shear force (WBS) of the TC steaks (4.75 kg) was lower ($P<0.05$) than the C samples (5.54 kg). The posterior region of the LM was not different ($P>0.05$) in WBS between TC and C which was attributable to the farther distance from the treatment site. Lee-Kramer shear force data were similar to the results of

WBS. Trained sensory panelists determined that TC steaks had higher (14.8%, $P<0.05$) scores for myofibrillar tenderness and overall tenderness (13.9%) than C steaks. TC steaks were not different ($P>0.05$) in sensory juiciness or connective tissue score compared to the C samples. Prerigor carcass muscle stretching can improve the tenderness of beef from Holstein cows.

Key Words: Holstein, Prerigor, Tenderness

268 Composition and consumer perception of fresh beef bonded with Activa™ TG-RM. D.S. Kollé*, B.L. Kollé, and J.W. Savell, Texas A&M University, College Station, TX.

Objectives were to determine the effects of removing kernel fat from ribeye rolls ($n = 24$ treated; $n = 24$ control) and connective tissue from top blades ($n = 24$ treated; $n = 24$ control) on percent dissectible components, chemical analyses, energy measurements, and consumer evaluations of steaks. For treated cuts, the kernel fat that lies within the ribeye between the *Spinalis dorsi* and the *Longissimus thoracis* was removed. For the top blade, the *Infraspinatus* was cut open and the heavy connective tissue within the muscle was removed. Control cuts were left intact. A 0.5% dry-sprinkle application of Activa™ TG-RM/sodium caseinate mixture was applied to treated cuts to serve as a binding agent. Steaks were assigned randomly to: 1) raw analysis; 2) cooked analysis; or 3) in-home sensory evaluation. Steaks were dissected into separable lean, fat, connective tissue, and inseparable tissue. Chemical analyses were conducted to determine moisture, fat, and protein content, and results were determined for protein calories, fat calories, and total calories. Additional ribeye rolls ($n = 12$ treated; $n = 12$ control) and top blade roasts ($n = 10$ treated; $n = 10$ control) were used for a consumer retail case study. Modified raw ribeyes were higher ($P < 0.05$) in percent dissectible lean, chemical protein, and chemical moisture, in addition to being lower in percent dissectible fat, chemical fat, and total energy. Treatment increased the percent dissectible lean and percent chemical protein, while reducing the percent dissectible connective tissue for raw top blades. Cooked data for both cuts were similar to the findings for the raw data. In-home sensory evaluations showed consumers rated modified ribeye steaks higher for leanness. The removal of kernel fat did not negatively affect evaluations for tenderness, juiciness, and flavor. Consumers rated treated top blade steaks higher than controls for all sensory characteristics. Consumer case data suggested that consumers chose treated ribeyes over control ribeyes due to leanness, and treated top blade steaks over control steaks because of perceived marbling. Modifying retail cuts to remove excessive seam fat and connective tissue appears to be an effective tool in increasing the nutritional composition and purchasing characteristics of steaks.

Key Words: Beef, Consumer preferences, Composition

269 The effects of calcium loading on tenderness of beef Longissimus, Supraspinatus and Semitendinosus muscles. D.J. Hanson*¹, C. R. Calkins¹, and J.M. Horton², ¹University of Nebraska-Lincoln, ²Kemin Industries, Inc., Des Moines, IA.

Calcium is needed for postmortem proteolysis of muscle. This experiment was designed to evaluate the hypothesis that high calcium, oral drench administered immediately prior to slaughter would hasten the effects of aging and/or increase overall muscle tenderness of beef *Longissimus*, *Semitendinosus*, and *Supraspinatus* muscles. Forty-two ($n=14$ /treatment) crossbred steers were treated 35 to 125 min prior to slaughter with one of three solutions. One group served as a control and received 1 L of distilled water; the other two groups were drenched with 1 L of calcium chloride or calcium propionate (NutroCAL™), that provided 150 g of elemental calcium. The muscles were removed about 24 h postmortem and 2.54 cm steaks were removed after 2, 5, 7, 14, and 21 d postmortem for Warner-Bratzler shear force determination, except that the size of the *Supraspinatus* prevented sampling after 7 d. Calcium chloride-treated steers had higher serum calcium levels ($P<.10$) than controls or calcium propionate treated steers. *Longissimus* muscles from calcium propionate-treated steers tended to have higher levels of muscle calcium than controls and calcium chloride-treated steers and numerically lower shear force values at 2, 5, 7, and 14 d than controls. No differences in muscle calcium or shear force values were detected among treatments for *Semitendinosus* and *Supraspinatus* muscles. Sarcomere lengths were not different among treatment groups, indicating that differences in muscle calcium did not create differences in muscle

shortening. These data suggest subtle benefits to *Longissimus* tenderness from calcium propionate (NutroCALTM) treatment of steers prior to slaughter.

Key Words: Beef, Tenderness, Calcium

270 Inhibition of lipid oxidation with encapsulated phosphates in muscle foods. J.R. Claus^{*1}, H. Wang², N.G. Marriott², and W.N. Eigel², ¹University of Wisconsin-Madison, ²Virginia Polytechnic Institute and State University.

The objective was to determine if encapsulation would improve the antioxidative property of phosphate in cooked muscle foods. Encapsulation of phosphate was done to protect the phosphate from endogenous phosphatases during the raw meat manufacturing steps. An initial experiment involved incorporation of encapsulated phosphates (0.5% sodium tripolyphosphate, STP or 0.5% sodium acid pyrophosphate, SAPP; meat weight basis) into ground beef patties that were immediately heat processed before storage (3 C). Phosphates were encapsulated with a hydrogenated vegetable oil designed to melt at 74 C (STP) or 60 C (SAPP). Unencapsulated STP samples had the lowest (P<0.05) cooking loss. Thiobarbituric Acid Reactive Substances (TBARS) were lower (P<0.05) for the phosphate treatments compared to control samples (no phosphate) on day 0 and 6. Unencapsulated STP samples had lower (P<0.05) TBARS than the other phosphate treatments on day 0. However, there were no differences (P>0.05) in TBARS among the phosphate treatments on day 6. A subsequent experiment involved delay of heat processing after phosphate encapsulation. Ground turkey meat with 1% NaCl was incorporated with unencapsulated STP (0.3% or 0.5%), encapsulated STP (0.3% or 0.5% phosphate), or a blend of unencapsulated (0.3%) and encapsulated (0.2%) phosphate and compared to a control. Treated ground turkey was stored (4 and 24 h, 3 C) before cooking to two different endpoints (74 and 79 C). Cooked turkey was stored (3 C) for 0, 5, and 10 days. An improvement of 77% and 80% in the reduction of TBARS was found with the 0.3% and 0.5% encapsulated STP, respectively, in comparison to the unencapsulated STP. TBARS on day 10 from samples stored 24 h before cooking were higher (P<0.05) than the samples stored 4 h prior to cooking. Encapsulation

ASAS Nonruminant Nutrition: Amino Acids, Vitamins, and Minerals in Finishing Pigs

272 Evaluation of synthetic L-Lysine use in finishing pigs. D.C. Kendall^{*1}, G.L. Allee¹, and J.L. Usry², ¹University of Missouri-Columbia, ²Ajinomoto Heartland Inc..

An experiment was conducted with finishing pigs (n=150 PIC C-22 x 337; initial BW = 70 kg) to evaluate the use of synthetic L-Lys on pig performance and carcass characteristics. Pigs were fed one of five dietary treatments with 6 replicates and housed at 5 pigs/pen. Pigs were fed an early finishing diet (EF) until 93 kg and late finishing diets (LF) until 115.5 kg. Diets consisted of a corn-soy positive control, a corn-soy negative control, .15% added L-Lys, .225% added L-Lys, and .30% added L-Lys. Dietary CP for the EF period were 16.1, 14.8, 13.1, 12.3 and 11.5%, respectively, and 13.9, 13.0, 11.2, 10.5, and 9.7%, respectively, for the LF period. True ileal digestible (TID) lysine levels were .71 and .57% for the positive control in the EF and LF. All other diets were formulated at .63 and .51% TID Lys for EF and LF. Ratios of TID Thr and Trp values were maintained relative to lysine of .63 and .20 in EF, .68 and .185 in LF with the addition of synthetic L-Thr or L-Trp. All diets were formulated to be equal on a modified ME basis. Pigs were weighed biweekly to determine average daily gain, average daily feed intake and feed efficiency. In addition, ultrasound measurements were taken on d 0 and at slaughter to determine tenth rib backfat depth and loin eye area. During the EF phase, no differences were observed in ADG or ADFI, however G:F was poorer in pigs fed diets containing .225 and .30% added L-Lys (.335) compared to the positive control (.353; P<.05). During the LF phase and for the overall finishing period, no differences in growth performance were detected between the diets. Ultrasound measures of tenth rib back fat depth, loin eye area, and percent lean at slaughter did not differ between treatments. At no point were the growth performance or carcass characteristics different between the negative control and diets with added L-Lys. This study shows that finishing swine diets

of phosphates has the potential to retard lipid oxidation in further processed meats that required an extended raw meat processing time prior to cooking.

Key Words: Encapsulated phosphate, Lipid oxidation, Meat

271 Future for red meat consumption cannot be accurately evaluated by using per capita: A different approach, per adult human unit versus per capita. S. Hasimoglu^{*1}, ¹Continental Analytical Services Inc. Salina, KS.

While the world's population has doubled in the past century, its appetite for meat quadrupled reaching 200 million tons. Even though the World Bank is discussing normalization of per capita (PC) consumption, its erroneous use has rarely been challenged, as if it is the most viable unit that should be used in the evaluation of meat consumption. However, PC does not address detailed anthropometrics criteria. When data are presented on PC basis, the assumption must be made that a 6-month-old baby will consume as much meat as a mature person. Aiming to reduce the magnitude of errors inherent PC, a method has been developed for analyzing production and consumption in populations that accounts for variations among age groups within populations. Per adult human use (PAHU) allows standardization of any population and eliminates the "one size-fits-all" PC concept. Application of the PAHU and calculated age groups conversion factors are used in obtaining data presented below. The calculation of the PAHU of the USA population (1985 and 1995) indicated that consuming and producing 239 and 265 million PC was reduced to standardized 199 and 222 million PAHU populations, respectively. Considering equally populated Sweden and Zimbabwe (8.3 million in 1985) and the world PC average meat consumption 29.6 kg/yr, their meat requirements would be 240 000 and 167 000 t/yr respectively. Percentage unit (PU) deviations of PAHU red meat consumption from PC were significantly different; 14.8 and 32.8 PU for Sweden and Zimbabwe respectively. The methodology underlying PC estimate of red meat consumption is an indirect procedure of arriving at a conclusion by disregarding not only the younger but the older portion of the population and the calculated unintended faulty level is not less than 15.86 PU as compared to PAHU. Simply, on the red meat consumption and production predictions, we are trying to find the right answer with the wrong unit, PER CAPITA.

containing up to .30% synthetic L-Lys, supplemented with L-Thr and L-Trp, does not affect growth performance or carcass characteristics.

Key Words: Pigs, Reduced crude protein, Lysine

273 Heat-damaged protein has reduced ileal true digestibility of cystine and aspartic acid in chicks. E.L. Miller^{*1}, Y.X. Huang¹, S. Kasinathan¹, B. Rayner¹, U. Luzzana², V.M. Moretti², F. Valfr², K. R. Torrissen³, H.B. Jensen⁴, and J. Opstvedt⁵, ¹University of Cambridge, ²Universit degli Studi di Milano, Italy., ³Institute of Marine Research, Norway., ⁴University of Bergen, Norway., ⁵Norwegian Herring Oil and Meal Industry Research Institute, Norway.

Low temperature fish meal (LT) has better digestibility than regular fish meal (R) in mink. Model systems have shown heat processing of fish muscle between 70 and 120C reduces SH groups and causes racemization of L to D aspartic acid. The objective was to determine the SH content, the extent of racemization of aspartic acid and ileal true digestibility (TD) of amino acids in chicks of Norse LT 94[®] compared with regular NorSeaMink[®]. Reactive SH was determined using three methods: 1) reaction with dithiodipyridine, 2) reaction with monobromobimane, and 3) reaction with 4-vinyl pyridine and HPLC separation. Values (mmoles/100 g CP) were LT 2.38, 2.57, 2.11; R 0.62, 0.70, 0.13 by methods 1, 2, 3 respectively. The proportion of D-aspartate (D/D+L) was determined by HPLC separation of the isomers following hydrolysis with 6M HCl at 100C for 6 h to minimize hydrolysis-induced racemization. D/D+L aspartate was 0.004 in freeze dried fish muscle compared with 0.030 in LT and 0.056 in R. Hydrolysis corrected values were LT 0.026, R 0.052. Ileal true digestibility was determined by slaughter of 11 day old chicks fed diets with 0 (200 enzyme hydrolysed casein plus amino acids), 150, 200, 250 g CP/kg of each fish meal as the sole protein

source and chromic oxide as marker. TD was calculated as 1-slope of the regression of ileal N or amino acid on diet N or amino acid. TD for N, cyst(e)ine (as cysteic acid), aspartate, D-aspartate, indispensable amino acids were: LT 0.930.009, 0.890.015, 0.920.007, 0.760.029, 0.940.009; R 0.870.012, 0.750.021, 0.800.013, 0.330.053, 0.880.011. LT meal had more SH and less S-S bonds and D-aspartate than R. TD of all amino acids was better for LT especially cyst(e)ine and aspartate. TD of D-aspartate was particularly low in R.

Key Words: Fish meal, Sulfhydryl, Racemization

274 Effect of increased levels of crystalline essential amino acids on growth performance and nitrogen retention of broiler chicks fed low-CP diets. K. Bregendahl* and D.R. Zimmerman, *Iowa State University, Ames.*

Bioavailability of crystalline AA (cAA) in low-CP diets may be lower due to destruction before consumption (i.e., Maillard reactions) or inefficient use during digestion/absorption. Therefore, an experiment was conducted to investigate whether increased dietary levels of cAA improve the growth performance and N retention of broiler chicks fed low-CP diets. A total of 306 day-old broiler chicks was fed a common corn-soybean meal (SBM) diet (24% CP) for 1 wk, after which the chicks were allotted to one of five diets (D) in a completely randomized design (10 chicks per pen, 6 replications; 146 g initial BW). Chicks had free access to the isoenergetic diets (3.20 Mcal ME_n/kg), which consisted of a control diet (D1; 24.0% CP), D2 (18.5% CP), D3, D4, and D5. The CP content of D2 was reduced by altering the corn:SBM ratio in D1 and adding cAA (Arg, Ile, Lys, Met, Thr, and Val) to 105% of NRC (1994) AA levels. Diets D3, D4, and D5 were formulated by increasing the cAA levels in D2 by 15, 30, and 45%, respectively, replacing Glu (making D2 though D5 isonitrogenous). After 2 wk on test, chicks were weighed, fasted for 24 h, and two chicks per pen were euthanized. The whole-body N contents of the chicks fed D1 through D5 as well as six baseline chicks were determined. Treatment means were compared using orthogonal contrasts. ADG (52.2, 50.6, 49.9, 49.3, 49.6 g/d for D1, D2, D3, D4, and D5, respectively), ADFI (68.6, 72.1, 71.2, 70.7, 69.8 g/d), feed utilization (G:F; 0.762, 0.701, 0.701, 0.697, 0.711), and N retention (1.45, 1.31, 1.30, 1.26, 1.26 g/d) of chicks fed D1 were superior ($P < 0.05$) to that of chicks fed D2 through D5. No linear or quadratic effects ($P > 0.10$) of increasing the cAA levels were observed on ADG or G:F, while ADFI ($P = 0.01$) and N retention ($P = 0.06$) decreased linearly. Based on these data, growth performance and N retention of chicks fed low-CP diets are not improved by increasing the amounts of dietary cAA above that needed to supply essential AA at NRC (1994) recommended levels

Key Words: Low Crude Protein, Performance, Crystalline Amino Acids

275 Supplemental fat and/or reduced dietary crude protein effects on growth performance, carcass characteristics, and meat quality of late finishing barrows reared in a controlled hot environment. J.D. Spencer*¹, A.M. Gaines¹, G. Rentfrow¹, W. Cast², J. Usry³, and G.L. Allee¹, ¹University of Missouri-Columbia, ²Premium Standard Farms, ³Ajinomoto Heartland Inc..

A total of 196 barrows (88 kg) were housed in a finishing facility (7 pigs/pen) with temperatures cycling between 29.4 and 35°C. A 2x2 factorial with two CP levels (13.6 or 11.3%) and two added fat levels (1 or 8%) allowed for 7 replicates (pens)/trt. All diets were corn/sbm and formulated to the same digestible lysine:ME ratio. Diets were fed until pigs approached 114 kg. Pigs were ultrasound for 10th rib backfat (ultBF) initially and before slaughter. Fat-o-meter fat depth (FOMBF), ham and loin 45 minute pH (45pH), ultimate ham pH(ultHpH), ham Hunter score (Ham L*), and total body electrical conductivity of the cut ham were taken from all pigs after slaughter. The right loin from 25 pigs/trt was subjected to pH measurement (ultLpH), loin intramuscular-fat content (IM), Hunter score (loin L*), and storage (14-d vacuum-sealed whole loin and 7-d retail display). Pigs fed the high CP/low fat (control) grew slower than all other trts ($P \leq .08$). However, high fat resulted in improved G:F regardless of CP level ($P \leq .01$). High fat diets had greater FOMBF, while high fat or lower protein both increased ultBF ($P \leq .05$). Reduced protein decreased ham weight and ham lean weight ($P \leq .04$). There was no difference in loin or ham 45 pH ($P \geq .05$), but low CP diets had lower ultHpH ($P \leq .05$). Pigs fed high fat diets had lower (darker) L* values at the ham face, as well as on the cut loin surface prior to

and after the 14-d vacuum seal and 7-d retail display. UltLpH was also higher with high fat inclusion ($P \leq .10$). Low CP fed pigs displayed less purge loss after the 7-d retail display ($P \leq .06$) and 14-d storage ($P \leq .19$). There was no difference in IM among treatments. These results suggest that 8% added fat or reduced dietary CP content (2.3%) improves finishing pig growth rate in hot environments, and fat inclusion improves G:F and meat quality regardless of CP level.

Key Words: Pigs, Temperature, Meat quality

276 A rapid method to determine “true metabolic availability” of amino acids in feedstuffs for pigs. R.O. Ball*, R.F.P. Bertolo, P.B. Pencharz, and S. Mhn, *University of Alberta.*

Some digested and absorbed amino acids (AA) in feeds cannot be used for protein synthesis by the pig. True ileal digestibility does not account for metabolically unavailable AA (eg Maillard products). The proportion of these unavailable AA varies with the growing and processing conditions for feedstuffs, preventing accurate diet formulation. We developed a rapid method (2 weeks), based on the indicator AA oxidation technique, to determine the “true metabolic availability” (MA) of AA for protein synthesis. Increasing AA intake below the requirement decreases indicator AA (phenylalanine, PHE) oxidation inversely to protein synthesis. Per unit AA intake, the MA of a feedstuff is equivalent to the decrease in oxidation relative to that supported by the free form of the test AA. Four catheterized barrows were fed a base diet for 7 d at 95 g/kg^{0.75}. Test diets were then fed for 2 d after which PHE oxidation was determined twice on subsequent days. The 5 test diets were: low lysine (LYS, 56% of requirement), low LYS + free LYS (90% of requirement), low LYS plus either raw peas or heated peas or heated peas + LYS (90% of requirement). PHE oxidation was quantified during 4h primed constant infusions of 425.0 (SE 6.9) kBq/h of L-[1-¹⁴C]-PHE. The first 2 diets provided the change in oxidation per g added free LYS, which is deemed 100% available, to predict MA of lysine in the other diets. In raw peas, MA was 65.3%, and in heated peas, MA was -2.9% of that of free LYS, indicating that the heating rendered the LYS in peas totally unavailable. When adding back free LYS to the level in raw pea diet, LYS MA was 64.9%, similar to raw pea diet. This indicates that the change in oxidation due to heating was entirely due to the change in dietary available LYS content. The present rapid method can be used to determine the MA of LYS and other AA in feeds. Using such information to formulate pig diets more accurately would result in more consistent performance and cost-efficient production.

Key Words: Pig, Lysine availability

277 A method to measure the amino acid requirement of individual pigs. S. Mhn*, R.F.P. Bertolo, and R.O. Ball, *University of Alberta.*

Although amino acid requirements for growing pigs are well established, there are no estimates of their variation in the population determined by measurements on individual pigs. We chose the indicator amino acid oxidation method (IAAO) to determine the lysine (LYS) requirement in individual pigs for an estimate of the mean requirement and its variation. When LYS intake increases, the relative excess and oxidation of the indicator (phenylalanine, PHE) diminishes. PHE oxidation remains constant once the LYS intake exceeds the requirement for protein synthesis. Oxidation is measured by quantifying the ¹⁴CO₂ release from a primed, constant infusion of L-[1-¹⁴C]-PHE. Four individually housed barrows (18.0kg SE 1.8) were surgically implanted with venous catheters for isotope infusion. They were offered, in random order, isonitrogenous and isoenergetic diets with 7 lysine concentrations (56, 67, 78, 90, 101, 123 and 145% of requirement, NRC, 1998) at 95 g/kg^{0.75}. After a validated minimum adaptation time of 2 days, indicator oxidation was determined for each dietary lysine level during 4 h primed, constant infusions of L-[1-¹⁴C]-PHE at a rate of 470.9 kBq/h (SE 17.1). The LYS requirement was calculated using a linear broken line model within individual pigs. For each pig, PHE oxidation decreased linearly ($P < 0.05$) as the LYS level increased until the requirement was reached; thereafter, PHE oxidation remained constant. The LYS requirement was 94, 99, 101, 117% of the NRC (1998) values for the four individual animals. The mean requirement for all pigs was 103.10%, in agreement with the estimate by NRC (1998). The IAAO method gives values for LYS requirements similar to conventional methods. The short (<3 weeks) experimental period allows, for the first time, the generation of an estimate of population variability. This allows the calculation of the effect of choosing a

specified safety factor on herd performance. This method is suitable to use with all dietary indispensable amino acids.

Key Words: Growing pig, Lysine requirement, Variation

278 Protein requirement re-evaluated for juvenile rainbow trout (*Oncorhynchus mykiss*). Zongjia Cheng*, R.W. Hardy, E.L. Brannon, and M. Casten, *University of Idaho, Hagerman, ID.*

Seven experimental diets (3,600 kcal DE/kg diet) were made with CP levels ranged from 27 to 45% (as fed basis) at 3% increment to evaluate the protein requirement for juvenile rainbow trout (initial BW 11.3 g) using practical feed ingredients. Fish were stocked into twenty-one 150 L fiberglass tanks with 3 tanks per treatment (diet), each tank was supplied with 4 L/min of untreated, constant temperature (14.5 C), spring water at the Hagerman Fish Culture Experiment Station, University of Idaho. Fish were fed 3 time/d and 6 d/wk to apparent satiation for a period of 6 weeks. Results showed that there were significant differences among treatments in weight gain (WG, $P < .0001$) and feed conversion ratio (FCR, $P < .01$). WG was 14.9.8, 16.21.2, 17.91.0, 19.8.8, 21.1.6, 22.31.9 and 21.11.3 g; FCR was 1.4.1, 1.4.1, 1.3.1, 1.2.0, 1.1.0, 1.1.1 and 1.1.1 g feed/g gain, for fish fed 27, 30, 33, 36, 39 and 42 and 45% CP diets, respectively. Quadratic regression based on WG revealed that the CP requirement for juvenile rainbow trout was 42.24% (as fed basis), the relationship can be expressed as: $WG = -0.026(CP)^2 + 2.1963(CP) - 26.122$ ($R^2 = .8959$); The CP requirement for juvenile rainbow trout was 44.08% (as fed basis) based on FCR, and the relationship can be expressed as: $FCR = 0.0012(CP)^2 - 0.1058(CP) + 3.3932$ ($R^2 = .9537$). These data showed that the CP requirement for juvenile rainbow trout fed practical diets was higher than NRC (1993) recommended values of 38% (as fed basis).

Key Words: Protein requirement, Rainbow trout, Weight gain, Feed conversion ratio

279 Effect of genotype and dietary lysine content during the grower phase on growth performance, serum urea N, and carcass and meat quality. J. Fabian*, L. I. Chiba, D. L. Kuhlers, L. T. Frobish, C. R. Kerth, K. Nadarajah, W. H. McElhenney, and B. L. Anderson, *Auburn University, Auburn, AL.*

A total of 32 select line (SL) and 32 control line (CL) Duroc pigs were used in two trials to determine the effect of selection for lean growth efficiency and dietary lysine content during the grower phase on pig performance. In each trial, pigs weighing 20 kg were assigned to 16 pens with two gilts or two barrows per pen, and pens were randomly assigned within genetic lines to one of the four grower (G) diets (0.5, 0.7, 0.9, or 1.1 g lysine/kg diet). After 50 kg BW, all pigs were fed finisher 1 (F1; 50-80 kg BW) and finisher 2 (F2; 80-105 kg BW) diets formulated to meet the NRC nutrient requirements. Pigs were allowed ad libitum access to feed and water. Blood samples were taken from each pig at 20, 50, and 105 kg BW. Pigs were subjected to ultrasound backfat (UBF) measurement at 50 and 105 kg BW. The initial statistical analyses revealed that variances between the two trials were homogeneous, thus the data were combined. During the G phase, pigs consumed less feed [linear (Ln), $P < 0.001$] and grew faster (Ln, $P < 0.05$) and more efficiently (Ln, $P < 0.001$) as the dietary lysine level increased. With the increasing dietary lysine content, pigs had lower UBF (Ln, $P < 0.001$) and higher serum urea N (Ln, $P < 0.001$) at the end of the G phase. However, during the F1 and F2 phases, pigs grew faster (Ln, $P < 0.01$ and $P = 0.07$, respectively) and more efficiently (Ln, $P < 0.05$) as the lysine content of the G diets decreased, resulting in no differences in overall growth performance or carcass and meat characteristics. The SL pigs grew faster ($P < 0.01$), and had lower 10th rib backfat ($P < 0.001$) and larger longissimus muscle area ($P = 0.08$) than the CL pigs, which were reflected in higher estimated daily lean gain ($P < 0.001$). The SL pigs had lower meat color ($P < 0.05$) and firmness ($P = 0.07$) scores. These results indicate that pigs exhibited compensatory growth after dietary lysine restrictions during the G phase, and were able to compensate fully. Although SL pigs had superior growth rate and body composition, both genetic lines responded similarly to the dietary restrictions.

Key Words: Pigs, Genotype, Compensatory growth

280 Lysine level required to optimize the growth response of Paylean™ in PIC pigs. R. D. Boyd*¹, M. E. Johnston¹, J. L. Usry², C. E. Fralick³, A. A. Sosnicki¹, and B. Fields¹, ¹PIC USA, Franklin, KY, ²Heartland Lysine Inc, Chicago, IL, ³Swine Tek, Van Wert, OH.

A trial was conducted with 456 PIC 337 × C22 pigs to determine the lysine level that allows full growth expression to Paylean™ (9g/909 kg). This dose was expected to yield about 70-85% of the maximum growth and carcass response. Females (240) and castrated males (216) were allocated by gender and weight to groups of 10 or 9 pigs/pen, respectively. Individual weights were taken at the start (92 ± 3 kg) and at the end of the 28 day trial. Corn-soy diets were used to formulate to 0.78% total lysine (Control, without Paylean™) and with Paylean™ (diets 2-5) having 0.78%, 0.90%, 1.02% or 1.14% lysine from intact protein. Diets 6 and 7 also contained Paylean™, but were formulated to 0.90% and 1.02% total lysine using 0.225%, 0.030% and 0.077% synthetic lysine, methionine and threonine, respectively. Pigs fed the Control diet had an ADG of 1.095 kg/d and a feed conversion ratio (G:F) of 0.34. The G:F ratio was improved ($P < .01$) with addition of Paylean™ to the 0.78% lysine diet (2). However, ADG was not improved when compared to pigs fed the Control diet. A linear improvement in ADG ($P < .05$) and G:F ($P < .01$) was observed for pigs fed diets containing Paylean™ with increasing lysine (diets 2-5): 1.145 and 0.371; 1.250 and 0.393; 1.195 and 0.398; 1.268 and .407, respectively. Pigs fed diets formulated with intact protein (3, 4) performed identical to those formulated with practical levels of synthetic amino acids (6, 7, $P > .50$). The lysine level that optimized growth declined in a step-wise manner. Using G:F ratio: week 1, 1.14% (0.562 vs 0.400); week 2, 1.02% (0.439 vs 0.366); week 3, 0.90% (0.327 vs 0.287); 0.90% total lysine approximated the requirement for the 28 day period. This level resulted in about 4 kg of added body weight and 1.8% carcass yield with 1.5 mm less backfat. Response to Paylean™ is dependent on adequate amino acid intake. The decreasing lysine requirement coincides with a declining response to Paylean™ with time.

Key Words: Pigs, Ractopamine, Lysine

281 Effects of supplemental trace mineral levels on carcass characteristics and carcass value. E. van Heugten*¹, P. R. O'Quinn², D. W. Funderburke², W. L. Flowers¹, and J. W. Spears¹, ¹North Carolina State University, Raleigh, ²Cape Fear Consulting LLC, Warsaw, NC.

A total of 6,024 pigs was used to determine whether reducing supplemental trace mineral (TM) levels during the grower-finisher phase has a negative impact on carcass traits and economic value. Pigs were randomly distributed into 4 blocks of 2 barns, ensuring that each block of barns was filled at the same time. Barns were then allotted within block to receive either diets with low or high TM supplementation. Four diet phases were fed with 135, 125, 105, and 85 ppm added Zn, 13.5, 12.5, 10.5, and 8.5 ppm added Cu, and 113, 104, 87.5, and 70 ppm added Fe for the high TM diets and 30 ppm added Zn, 6 ppm added Cu, and 30 ppm added Fe for all low TM diets. Diets were analyzed to contain 181, 155, 142, and 135 ppm Zn, 17, 21, 19, and 18 ppm Cu, and 506, 477, 352, and 299 ppm Fe for the high TM diets and 80, 75, 79, and 80 ppm Zn, 12, 8, 10, and 10 ppm Cu, and 389, 368, 270, and 271 ppm Fe for the low TM diets. Pigs averaged 19.1 and 21.2 kg for the high and low TM treatments, respectively ($P = 0.19$), at placement. Pigs were slaughtered at a commercial plant and sex and carcass data were determined for each individual pig. Data were analyzed by split-plot analysis using treatment as whole plot and sex as split-plot. Barrows had greater carcass weight (90.1 vs 87.7 kg; $P < 0.003$), fat depth (20.1 vs 17.3 mm; $P < 0.001$), carcass weight payment (\$110.52 vs 108.55; $P < 0.04$) and lower % lean (53.6 vs 55.4%; $P < 0.001$) and lean premium payment (\$1.50 vs 3.55; $P < 0.001$). Pigs fed low TM diets had greater carcass weight (89.5 vs 88.3 kg; $P < 0.06$), carcass weight payment (\$110.54 vs 108.53; $P < 0.04$), and total payment (\$112.98 vs 111.07; $P < 0.02$) compared to pigs fed high TM diets. Backfat thickness, loin depth, % lean, and lean premium payment were not affected ($P > 0.10$) by dietary treatments. Results indicate that reducing trace mineral levels in diets for grower-finisher pigs had no negative effects on carcass characteristics or value of the carcass.

Key Words: Swine, Minerals, Carcass

282 Differential response from feeding high levels of vitamin E on quality of stored pork from two genotypes. J. L. Hasty*, E. van Heugten, and M. T. See, *North Carolina State University, Raleigh.*

This study examined the effects of feeding high levels of vitamin E on the quality of stored pork from different genotypes. Pigs (n=240; initial BW=87 kg) were allotted by weight to one of ten treatments (8 pens/trt, 3 pigs/pen) in a 2 x 5 factorial arrangement. Factors included: 1) genotype (Berkshire sired and Hampshire sired) and 2) supplemental levels of vitamin E (0, 75, 150, 300 and 600 mg/kg). Corn-SBM basal diets containing 2.5% added fat, 0.83% lysine and 15 mg/kg vitamin E were fed for 6 weeks. Drip loss, color, and TBARS were measured in loin chops displayed for 0, 2, 4, 6, and 8 d at 4°C. Drip loss from Hampshire crosses was greater (3.16 vs. 1.77%; $P < 0.001$) compared to Berkshire crosses, but was not affected by vitamin E level ($P > 0.10$). Chops from Berkshire crosses were darker (L^* : 52.4 vs. 54.3; $P < 0.05$), less red (a^* : 7.87 vs. 8.94; $P < 0.001$), and less yellow (b^* : 7.87 vs. 8.71; $P < 0.05$) compared to Hampshire crosses, but were not affected by vitamin E level ($P > 0.10$). Greater oxidation (TBARS) occurred in Hampshire cross display chops (day x genotype; $P < 0.01$) on d 0 (0.77 vs. 0.65; $P < 0.02$), d 4 (1.09 vs. 0.83; $P < 0.001$), d 6 (0.62 vs. 0.47; $P < 0.002$) and d 8 (1.31 vs. 1.17 mg MDA/kg sample; $P < 0.01$). TBARS (day x vitamin E; $P < 0.06$) decreased linearly on d 4 (1.13 to 0.79; $P < 0.001$), d 6 (0.76 to 0.48; $P < 0.02$) and d 8 (1.40 to 1.04 mg MDA/kg sample; $P < 0.001$) with increasing levels of vitamin E. TBARS in display chops from Hampshire cross (genotype x vitamin E; $P < 0.02$) decreased linearly (from 1.02 to 0.66 mg MDA/kg sample; $P < 0.001$) with increasing vitamin E level. These data reinforce that Hampshire crosses produce paler, more exudative pork that is more susceptible to oxidation than Berkshire crosses. However, increasing supplemental vitamin E levels will improve storage as indicated by reduced oxidation of lower quality pork, but will not impact oxidation in higher quality pork.

Key Words: Vitamin E, Pork, Quality

283 The effects of niacin on growth performance and meat quality in grow-finish pigs. D. E. Real*¹, J. L. Nelssen¹, M. D. Tokach¹, R. D. Goodband¹, S. S. Dritz¹, J. A. Unruh¹, and E. Alonzo², ¹*Kansas State University, Manhattan*, ²*Lonza Inc., Fair Lawn, NJ.*

Two experiments were conducted to determine the effects of additional dietary niacin on growth performance and meat quality in finishing pigs. All pigs were blocked on weight and assigned to one of six dietary treatments. Pigs were housed with 2 pigs per pen (6 pens/treatment/sex) in Exp. 1 and approximately 26 pigs per pen (4 pens/treatment/sex) in a commercial research barn in Exp. 2. In both trials, dietary treatments consisted of a corn-soybean meal-based control diet or the control diet with 27, 55, 83, 110, or 550 mg/kg additional niacin. In Exp. 1, 144 pigs (initially 51.2 kg) were fed diets in two phases from d 0 to 25 and d 25 to 62 that were formulated to 1.00 and 0.75% lysine, respectively. In Exp. 2, 1243 pigs (initially 35.9 kg) were fed diets in four phases (d 0 to 28, d 29 to 56, d 57 to 84, and d 85 to 117). Diets were formulated to 1.25, 1.10, 0.90, and 0.65% lysine in the respective phases and contained 6.0% added fat in the first three phases. In both trials, gilts grew slower ($P < 0.001$), were leaner at the tenth rib ($P < 0.03$), and had higher fat-free lean percentages ($P < 0.01$) than barrows. Overall, in Exp. 1, feeding additional niacin had minimal effects on growth performance. However, niacin tended to increase ($P < 0.06$) 24 hr pH (5.44, 5.49, 5.49, 5.46, 5.49, and 5.48). In the commercial environment in Exp. 2, increasing niacin increased (quadratic, $P < 0.05$) ADG (760, 775, 762, 775, 754, and 753 g/d) and improved (quadratic, $P < 0.01$) G/F (.352, .362, .357, .375, .367, and .366). Niacin supplementation also decreased (linear, $P < 0.04$) carcass shrink and drip loss percent (2.00, 1.90, 1.93, 1.90, 1.23, and 0.80) and increased (linear, $P < 0.01$) subjective color scores, L^* values, and ultimate pH (5.67, 5.73, 5.77, 5.76, 5.85, and 5.94). Results from these two studies show that additional dietary niacin can be

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286 Relationship between post-weaning performance and reproductive performance in first parity Landrace females. D. Newcom*, P. Chen, J. Mabry, and T.J. Baas, *Iowa State University, Ames, Iowa.*

Data from the National Swine Registry STAGES program were used to examine the relationship between the post-weaning performance

fed to pigs to improve pork quality as measured by drip loss, pH, and color.

Key Words: Niacin, Meat quality, Finishing pigs

284 Role of pantothenic acid as a modifier of body composition in pigs. T. S. Stahly and T. R. Lutz*, *Iowa State University, Ames, IA.*

Fifteen sets (7 barrows, 8 gilts) of four individually penned, littermate pigs were utilized to determine the effect of pantothenic acid (PA) additions on growth, body composition and meat quality in pigs fed from 10 to 118 kg BW. Pigs from a high lean strain were reared via a SEW scheme and self-fed a diet containing 19 ppm PA from weaning to 10 kg BW. Pigs were then fed a basal diet (analyzed 6 ppm PA) and allotted within litter to one of four dietary additions of PA (0, 30, 60, 120 ppm) from d-calcium pantothenate. The basal diet consisted of a corn-SBM-3% choice white grease mixture and contained 1.5, 1.2, and .95% lysine for pigs fed from BW of 10 to 46, 46 to 80 and 80 to 118 kg, respectively. All vitamins except PA were fortified to 600% of NRC (1998) for each stage of growth. As dietary PA concentration increased, longissimus muscle area increased quadratically (43.9, 48.0, 45.4, 47.5 cm², $P < .06$) and tenth rib backfat decreased quadratically (2.25, 2.04, 2.07, 1.95 cm, $P < .05$) resulting in a quadratic increase in fat-free lean (51.4, 53.4, 52.5, 53.6%, $P < .04$). The magnitude of these responses were larger ($P < .09$) for barrows than gilts. Daily body weight gain (933, 916, 940, 914 g) and gain:feed (429, 433, 428, 431 g/kg) were not altered by dietary PA. In addition, measures of meat (longissimus) quality including intramuscular fat content (4.4, 4.2, 4.6, 4.0%), Hunter L (54.5, 54.2, 54.3, 54.3) and Hunter a (8.7, 9.1, 8.9, 8.5) color values and water loss under retail storage (4.7, 4.9, 5.1, 4.7%) at 96 hours post-kill were not ($P > .10$) altered by dietary PA. Based on these data, dietary pantothenic acid at concentrations greater than that required to maximize body weight gain elicits reductions in subcutaneous fat thickness while increasing carcass lean content of market weight pigs without altering meat quality.

Key Words: Pigs, Pantothenic acid, Body composition

285 Impact of a targeted B-Vitamin regimen on rate and efficiency of growth on lean growth genotype pigs from 6 to 110 kilograms of body weight. M. Coelho, B. Cousins*, and W. McKnight, *BASF Corporation.*

Four hundred, four week old pigs (5.5 kg initial BW) were utilized in a 5x2 factorial design (10 reps/treatment) to determine the effects of five B-vitamin (riboflavin, pantothenic acid, niacin, B₁₂ and folic acid) fortification levels (NRC, 2X, 4X, 8X, 16X NRC) and two levels of stress (low and moderate) on the performance of 5.5 kg to 110 kg pigs (128 trial days). Diets were formulated to be isocaloric and isonitrogenous. The diets were fed in pellet form. Pigs raised under moderate stress conditions during performance period 1(19 days, 12 kg bw) gained 506^d, 533^{cd}, 544^{bcd}, 559^{abc} and 569^{ab} g/day and had corrected feed efficiency of 1.929^d, 1.899^{cd}, 1.889^{bcd}, 1.871^{abc} and 1.828^a when supplemented with NRC, 2X, 4X, 8X and 16X NRC B-vitamins, respectively. For the overall performance at 128 days pigs raised under moderate stress, had an ADG of 814^c, 829^{bc}, 844^{abc}, 850^{ab} and 865^a g/day had corrected feed efficiency of 2.583^c, 2.499^b, 2.466^{ab}, 2.444^{ab} and 2.419^a when supplemented with NRC, 2X, 4X, 8X and 16X NRC B-vitamins, respectively. Across stress levels, increasing vitamin supplementation increased loin eye area (39.72^c, 40.25^c, 42.96^b, 44.06^{ab} and 44.96^a cm²) and decreased backfat (16.65^d, 16.61^c, 16.41^{bc}, 16.06^a and 16.02^a mm) when supplemented with NRC, 2X, 4X, 8X and 16X, respectively. Pigs fed 16X NRC levels had a \$5.91/pig advantage and 500% return over 2X NRC and \$3.69/pig advantage and 400% return over 4X NRC.

Key Words: Swine, Vitamins, Performance

(growth, backfat, and loin muscle area) of Landrace females and their subsequent first parity reproductive performance. Genetic parameters were estimated from first parity Landrace females (n=5247) for which post-weaning performance had also been recorded. These records rep-

resented 710 sires and 2346 dams. Additive genetic (animal/gilt), common environmental (litter, c^2), mate (service sire for reproduction traits only), and residual variances and covariances were estimated for days to 113.5 kg (DAYS), tenth rib backfat (BF), loin muscle area (LMA), number born alive (NBA), and litter weaning weight (LWT) using the multiple-trait animal model REMLF90 program of Misztal. NBA was pre-adjusted for age and parity of sow and LWT for age of pigs at weaning while post-weaning performance traits were pre-adjusted to 113.5 kg. The model included fixed effects of contemporary group (both post-weaning and reproductive) and random effects of animal, litter, mate, and residual error. Heritabilities were similar to literature estimates. Common litter effects were high (.28) for DAYS. Genetic correlations between post-weaning performance and reproduction traits for first parity were generally low. Post-weaning performance traits have little effect upon subsequent first parity maternal performance.

	DAYS	BF	LMA	NBA	LWT
DAYS	0.33	0.13	0.06	-0.17	-0.15
BF		0.44	-0.57	-0.08	-0.07
LMA			0.34	-0.02	-0.13
NBA				0.13	0.30
LWT					0.12
c^2	0.28	0.18	0.13	0.03	0.14
Mate	—	—	—	0.03	0.04

Heritabilities on diagonal, genetic correlations above diagonal.

Key Words: Genetic parameters, swine

287 Effects of inbreeding of sow on reproduction and litter performance in a closed population of Landrace pigs. K. Nadarajah^{*1}, D.L. Kuhlers¹, S.B. Jungst², and B.L. Anderson¹, ¹Auburn University, AL., ²PIC, Franklin, KY..

Declines in growth and reproductive performance in livestock often sound the alarm that inbreeding depression may be a causal effect. However, many studies have reported inconclusive results. Five generations of single trait selection conducted in a line of Landrace pigs based on BLUP EBVs for increased ultrasound loin eye area at the Swine Breeding Research Unit in Auburn University resulted in an increase in average inbreeding of sows from zero in base generation to 19.4% and 6.4% in the select and control lines, respectively. The objective of this study was to examine the effects of sow's inbreeding levels on reproduction and performance of her litter. Data from 192 first parity sows that were progenies by 68 sires and out of 135 dams were available for this study. Traits analyzed were litter size at birth (LSB), number born alive (LSBA), number weaned at 21 d (LS21), number weaned at 35 d (LS35), litter weight at birth (LWTB), litter weight at 21d (LWT21) and litter weight at 35d (LWT35). Analyses were carried out using the mixed model procedure in SAS, fitting generation, line and generation by line interaction as fixed effects, inbreeding coefficient of the sow within line as covariate, and sire of the sow, dam of the sow and residual error as random effects. To adjust litter weights to common litter size, LSB, LSBA and LS21 were included as covariate in models for analyzing LWTB, LWT21 and LWT35, respectively. Inbreeding of sow did not significantly affect LSB, LSBA, LS21 or LS35 (P values ranged from .11 to .17) though the slopes of the regression lines for sow's inbreeding effect were negative for litter sizes. Regression slope for LSB in the select line differed from zero (P<0.05). Inbreeding levels of sow had no effect on LWTB and LWT35, but affected the LWT21 (P<0.05). The regression slopes were negative for LWT21 and LWT35 in both select and control lines. The LSB, LSBA and LS21 had significant influence on LWTB, LWT21 and LWT35 (P<0.001). Inbreeding of sow did not seriously affect reproduction or litter performance.

Key Words: Sow's Inbreeding, Reproduction, Litter Performance

288 Correlated responses in sow productivity in a line of Landrace pigs selected for increased ultrasound loin eye area. D. L. Kuhlers^{*1}, K. Nadarajah¹, S. B. Jungst², and B. L. Anderson¹, ¹Auburn University, AL, ²PIC USA, 3033 Nashville Road, Franklin, KY.

Positive genetic changes in lean muscle content in pigs might impose some negative effects on sow's productivity. Five generations of single trait selection conducted in a line of Landrace pigs for increased ultrasound loin eye area (ULEA) at the Swine Breeding Research Unit in AU showed a difference of 10.6 cm² in average EBVs between select (SL) and control (CL) lines for ULEA. The objective of this study was

to examine the impact of increased ULEA on sow productivity. Real-time ULEA data at the 10th rib of 1406 pigs at 168 d of age, and litter performance records for number born (NBORN), litter weight at birth (LITBWT), number weaned at 35 d (NWN35) and litter weight at 35 d of age (LITWT35) from 192 sows that had ULEA were used for this study. Heritabilities and genetic correlations were estimated by the multivariate REML procedure using MTDFREML. For ULEA, the model considered the fixed effects of generation, sex, covariate of 168 d weight, and random effects of animal, litter and error. For sow productivity traits, fixed effect of generation and random effects of animal and error were considered. Estimates of heritabilities for ULEA, NBORN, LITBWT, NWN35 and LITWT35 were .47, .07, .25, .25 and .53, respectively. Genetic correlations of ULEA with sow productivity and litter performance traits ranged from -.01 to -.38. The most undesirable genetic correlation was between ULEA and NBORN (-.38). Genetic correlations of ULEA with NWN35 and LITWT35 were -.20 and -.17, respectively. Genetic correlations among litter sizes and litter weights were all positive and ranged from .20 to .98. Average EBVs of SL sows that produced the fifth generation pigs were 1.31 and 1.04 less pigs/litter than CL sows for NBORN and NWN35, respectively. Compared to CL sows, the average EBVs of SL sows showed differences of -.63 and -12.0 kg/litter for LITBWT and LITWT35, respectively. Selection for increased ULEA appears to have some negative effects on sow productivity.

Key Words: Selection, Loineye Area, Sow Productivity

289 Models for predicting the market weight of finishing pigs based on current age and weight. H. I. Sellers^{*} and R. N. Goodwin, *National Pork Producers Council, Des Moines, IA.*

Data from the National Pork Producers Council's Maternal Line National Genetic Evaluation Program were used to develop prediction equations for weight of finishing pigs. The pigs represented barrows and gilts from six maternal genetic lines mated to a common terminal genetic type to produce four parities. Three replicates were performance tested for finishing growth and feed intake using the Feed Intake Recording Equipment (FIRE) system. Target market weight was 113.4 kg. In each replicate performance tested pigs had an initial and ending weight. In replicates 2 and 3 serial weights were recorded at approximately 21-day intervals. Three regression models were evaluated. In model 1 ending weight was fit to the linear and quadratic terms for initial weight and age and ending age. In Models 2 and 3 growth curve equations were developed by fitting initial, serial and ending weights to their corresponding linear and quadratic terms for age and to a logarithmic function of age, respectively. Model 1 error term was 25.29 kg (R²=0.26). The error terms for models 2 and 3 were 62.90 kg (R²=0.905) and 65.81 kg (R²=0.901), respectively. The computed equations were tested for equality of coefficients across barrows, gilts and each genetic type. For model 1 the hypothesis that the coefficients were the same for each sex and for each genetic type was accepted. For Models 2 and 3 the coefficients for barrows and gilts were significantly different (P<0.05), as were the coefficients for two of the six genetic types. These results suggest that a prediction equation for market weight based on current age and weight and projected market age is reasonably robust in that it is applicable across barrows and gilts and a range of genetic types. Predictions of market weight based on growth curves account for more of the variation and have greater standard errors. However, finishing growth curves tend to be specific for each sex and certain genetic types. This suggests that their application may dictate individual equations for barrows, for gilts and certain genetic types.

Key Words: Finishing, Prediction, Weight

290 Genetic correlations among piglet survival, birth weight and performance traits. E.F. Knol¹, R. Bergsma¹, J.W.M. Merks^{*1}, J.A.M. van Arendonk², and T. van der Lende², ²Animal Breeding and Genetics group, Wageningen, ¹IPG, Institute for Pig Genetics, Beuningen, the Netherlands.

Genetic relations between piglet survival and birth weight on one side and performance traits on the other were studied. Measurements were taken on animals in a commercial sire line. For birth weight and survival traits (farrowing, pre-weaning and total) 29,200 observations were available. Performance traits were measured in two test periods, one beginning at 294 kg and lasting 56 days (Phase1, 2019 observations) and one beginning at the end of Phase1 and lasting another 56 days (Phase2).

Daily gain and backfat thickness were available for both phases and feed intake only was available for Phase2 (1622 observations). Protein and lipid depositions were estimated for both phases and residual feed intake was estimated for Phase2. For birth weight a model with a direct and a maternal animal factor was used; this resulted in heritabilities of 0.05 and 0.20, respectively. The maternal component of birth weight had positive genetic correlations with lifetime daily gain (0.240.12), and estimated protein deposition during Phase2 (0.460.18) and a negative correlation with Phase2 backfat (-0.250.11). For pre-weaning survival a model with a direct (piglet) and a nurse sow animal effect was fitted. Estimated heritabilities were 0.02 and 0.03, respectively. The direct effect of pre-weaning survival had a positive genetic correlation with average daily feed intake (0.440.22), Phase1 backfat (0.410.19), Phase2 backfat (0.510.18), and lipid deposition during Phase2 (0.440.19) and a negative correlation with estimated residual feed intake (-0.640.28). The nurse sow effect of pre-weaning survival had a negative genetic correlation with Phase2 gain (-0.410.21) and especially with estimated protein deposition during Phase2 (-0.630.24). The study indicated that selection against backfat will increase birth weight and decrease piglet survival, while selection for increased pre-weaning survival will increase gain, feed intake and backfat.

Key Words: Piglet Survival, Genetic Parameters, Performance Traits

291 The Association Between the Estrogen Receptor Locus and Growth, Carcass, and Developmental Traits in Pigs. T. D. Leeds*, K. M. Irvin, and S. J. Moeller, *The Ohio State University, Columbus, OH.*

The association between the estrogen receptor (ESR) locus and growth, carcass, and developmental traits in swine was investigated in a population of purebred and crossbred Large White and Yorkshire animals. A total of 724 animals were genotyped at the ESR locus (AA, AB, or BB) via a PCR-RFLP procedure or by pedigree analysis and were measured for traits including teat number (TN), individual birth weight (IBW), weaning weight (WW), age at 109 kg (AGE), average daily gain (ADG), ultrasonic backfat thickness (BF), and loin-muscle area (LMA). WW, AGE, BF, and LMA measurements were adjusted to a standardized weight or age prior to the statistical analysis using guidelines provided by the National Swine Improvement Federation. Data were analyzed using a linear model including the fixed effects of ESR genotype, breed composite, sex, season, and parity and interactions including ESR genotype # breed and ESR genotype # sex. ESR genotype was found to be a significant ($P < 0.05$) contributor to the phenotypic variance for BF and nominally significant ($P < 0.10$) for IBW. Animals possessing at least one copy of the B allele had 0.156 0.059 cm more BF than homozygous A animals ($P < 0.01$). Heterozygous animals were 0.054 0.024 kg heavier at birth than the average of the homozygous animals ($P < 0.05$). There were no detectable ESR genotype effects for TN, WW, AGE, ADG, or LMA ($P > 0.10$). Results of this study give evidence of a QTL in the vicinity of the ESR locus affecting BF and IBW. Utilization of the ESR B allele in a marker-assisted selection program for increased litter size, as suggested in previous studies, may have a detrimental effect on BF.

Key Words: Estrogen Receptors, Backfat, Pigs

292 Estimation of genetic parameters for lactation yields of milk, fat and protein of New Zealand dairy goats. N. Lopez-Villalobos* and D. J. Garrick, *Massey University, Palmerston North, New Zealand.*

The New Zealand dairy goat industry is orientated to the production of dairy products for niche markets. Routine genetic evaluation for the identification of superior animals requires knowledge of the genetic parameters for traits of financial importance. Repeatabilities, heritabilities and genetic and phenotypic correlations for lactation yields of milk, fat and protein were obtained in this study. The data set comprised 22,358 lactation records from 9,443 Saanen, Nubian, Alpine, Toggenburg and crossbred does kidding between 1986 and 1999 in 30 co-operative herds. A total of 296 sires were represented. The raw average yields of milk, fat, and protein were 603.9304.0 L, 20.710.6 kg, and 17.88.8 kg, respectively from an average of 201.864.1 days in milk. Estimates of (co) variances were obtained using the ASREML program (Gilmour et al., 2000) with a multiple-trait repeatability animal model. The model included contemporary group (does kidding in the same herd, year and month), age of the doe, day of the month starting the lactation, proportion of genes from

Saanen, Nubian, British, Toggenburg, and "unknown" breeds, and individual heterosis as fixed effects, and random additive genetic and permanent animal effects. Repeatabilities for milk, fat, and protein yields were 0.420.008, 0.410.008, and 0.420.008, respectively. Corresponding heritabilities were 0.250.019, 0.240.019, and 0.250.019. Genetic correlations were 0.900.002 between milk and fat yields, 0.960.001 between milk and protein yields, and 0.920.001 between fat and protein yields. Phenotypic correlations were 0.810.017 between milk and fat yields, 0.930.007 between milk and protein yields, and 0.880.012 between fat and protein yields. Estimates of (co)variances from this study are currently used for the genetic evaluation of animals from the Dairy Goat Co-Operative (NZ) Ltd. Results from the genetic evaluation allows the selection of animals to be used as parents based on their estimated genetic merit and culling of lactating does based on producing ability.

Key Words: Dairy goats, Milk traits, Genetic parameters

293 Models for birth, weaning and fleece weights, and litter size for a population of Targhee sheep. L. D. Van Vleck*¹, G. S. Snowder², and K. J. Hanford³, ¹USDA, ARS, US-MARC, Lincoln, NE, ²USDA, ARS, USSES, Dubois, ID, ³University of Nebraska, Lincoln, NE.

Many models (17) were compared for birth weight of 33,994 lambs recorded at USSES (1950-1998). Initial intent was to estimate fractions of variance due to cytoplasmic line (c^2 ; 892) and sire by cytoplasmic line interaction (sc^2 ; 17,557). The basic model included direct genetic (fractional variance, a^2 ; 35,684), maternal genetic (m^2 , with correlation r -am), and maternal permanent environmental (p^2 ; 8,418) effects. The model with sc^2 was significantly better than the basic model with and without c^2 . When other random effects were added, sc^2 became zero. Significant effects were associated with dam by year (dy^2 ; 24,801), sire by dam (sd^2 ; 23,924) and dam by number born (dn^2 ; 12,944) random interaction effects. Estimates with all effects in the model were: (a^2 , .24; m^2 , .19; r -am, .11; p^2 , .05; c^2 , .00; dn^2 , .04; dy^2 , .06; sd^2 , .05; sc^2 , .00). Estimates for a^2 , m^2 , and r -am were the same for all models. Estimate of p^2 changed when other effects were added to model. Largest estimates for non-genetic effects were: p^2 , .08; c^2 , .00; dy^2 , .13; sd^2 , .11; and sc^2 , .04. With or without Westell groups (91) in the model, estimates were similar. For weaning weight (120-d, $n = 32,715$) estimates of variances of effects added to the basic model were all near zero (a^2 , .18; m^2 , .12; r -am, -.01; p^2 , .06). For number born (NB, $n = 37,020$) and fleece weight (FW, $n = 36,197$), animal permanent environmental effects were added to the model (ap^2 , 9,871 and 9,760) and r -am was dropped. For neither trait did any effects beyond the basic model have large variances. For NB, non-zero estimates with the full model were: (a^2 , .10; ap^2 , .01; dy^2 , .0; sc^2 , .01) and for FW were: (a^2 , .54; m^2 , .02; ap^2 , .02; dy^2 , .04 and sc^2 , .02). For these traits, cytoplasmic effects were not important. Addition of unusual random effects to the model did not change estimates for the basic model. Although some of these effects were significant, especially for BW, the effects on genetic evaluations are likely to be small.

Key Words: Extranuclear Effects, Genetic by Environment, Genetic Evaluations

294 Estimation of genetic parameters of lamb mortality using survival analysis. B. R. Southey*¹, S. L. Rodriguez-Zas¹, and K. A. Leymaster², ¹University of Illinois, Urbana, IL, ²USDA-ARS, U. S. Meat Animal Research Center, Clay Center, NE.

Mortality records from 8,642 lambs from a composite population at the US Meat Animal Research Center were studied using time-to-event Weibull and Cox sire models. To account for the different genetic and environmental sources of variation from birth to 365 d of age (BY), survival from birth to weaning (BW) and from weaning to 365 d of age (WY) were also studied. Records from lambs culled during the study were treated as censored on the day of culling. Male lambs had a significantly ($P < 0.01$) greater hazard of mortality (23 to 40%) than female lambs in all periods. Type of birth was significant ($P < 0.01$) in the BW and BY periods with multiple born lambs having a greater hazard of mortality than single- or twin-born lambs. Age of dam was significant ($P < 0.01$) in the BW and BY periods with lambs from 1-year-old dams having a greater hazard of mortality than those from older dams. Lambs raised by their dams had a significantly ($P < 0.01$) lower hazard than lambs raised in the nursery in all periods. Estimates of sire variance and heritability from the Weibull model were greater than those from

the Cox model in all periods. Modal estimates (and standard errors) of heritability from the Weibull and Cox models in the BW, WY and BY periods were 0.21(0.07) and 0.19(0.12), 0.15(0.05) and 0.16(0.06), 0.18(0.12) and 0.12(0.05), respectively. These estimates indicate potential for effective selection for increased lamb survival, enhancing sheep production and welfare.

Key Words: Sheep, Frailty, Cox and Weibull

295 Effect of duration of feeding on variance component estimation for ADG of lambs. G. D. Snowder*¹ and L. D. Van Vleck², ¹USDA, ARS, USSES, Dubois, ID, ²USDA, ARS, USMARC, Lincoln, NE.

Variance components were estimated from Targhee data collected from 1978 to 1984 on a total of 1,047 ewe and ram lambs at the U.S. Sheep Experiment Station, Dubois, ID. Lambs were fed for 14 wk with ADG recorded every 2 wk. Lambs were provided ad libitum access to a commercial pelleted feed of barley grain and ground alfalfa. ADG for the entire 14-wk period across all years was 249.3 ± 56.5 g. Variance components for ADG were estimated from a single trait animal model using REML for sequential combinations of duration of time on feed ($n = 9$) with a range of 4 to 14 wk. The model included fixed effects for year (1978 to 1984), sex of lamb (ewe or ram), and genetic line (selected or control), and two covariates (age on test and initial weight at beginning of feeding). Phenotypic variances for ADG decreased with extended time on feed: 0.54 and 0.14 g² at 4 and 14 wk on test, respectively. Estimates of direct heritability increased with extended time on feed; 0.20 ± 0.06 and 0.35 ± 0.07 at 4 and 14 wk on test, respectively. There was little increase of direct heritability estimates after 8 wk on feed (0.33, 0.33, 0.38, and 0.35 for 8, 10, 12, and 14 wk, respectively.) Genetic and environmental correlations among duration of feeding combinations ($n = 16$) were estimated from a two-trait model. All genetic correlations among duration of feed groups were greater than 0.82 and infer that all measures of ADG were genetically similar. However, environmental correlations among duration of feeding groups ranged from 0.41 to 1.00 with the smaller environmental correlations occurring between 4 or 6 wk and 12 to 14 wk on feed. These results indicate that a period of 8 wk or

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297 BASECOW: An Excel add-in specific for the dairy production consultant. DT Galligan*, H Groenendaal, R Munson, JD Ferguson, and H Aceto, *University of Pennsylvania, School of Veterinary Medicine.*

Basecow is an Excel add-in containing over 100 functions that are useful in animal production medicine consulting and modeling. Basic function categories currently include: epidemiology, nutrition, statistical, reproduction, production, and management. Once installed in Excel as an add-in, the functions can be used in any opened work book. Like any Excel function, Basecow functions require the user to enter a call name and a list of arguments appropriate to a given function: Function Name (argument1, argument n). Example (1) If 30 cows all test negative to a test with a sensitivity of 45% and specificity of 98%, what is the probability that at least 1 or more of the 30 are infected if the underlying prevalence of the disease is estimated at 5%? = **Grouppos(sensitivity, specificity, prevalence, number tested negative)** = Grouppos(.45, .98, .05, 30) = 58%. Example (2) What is the optimal economic order quantity (EOQ) for a feed additive costing \$800/ton, used at 40 tons/year, with an ordering cost of \$20/order and holding cost at 5%/year? = **EOQ(demand, order cost, holding cost/unit/year)** = EOQ(40,20,.05*800) = 6.3 tons/order. Example (3) What is the water intake of a cow weighing 1400 lbs, milking 80 lbs of milk at 3.6% fat? = **Waterlb(weight, milk, fat %, status)** = Waterlb(1400,80,3.6,L) = 289 lbs. The add-in is available for downloading at <http://CAHPWWW.NBC.UPENN.EDU> web site. The program is continually updated with new functions. An on line help system is available for many of the commands. The help menu describes command use through an example application and includes reference sources.

Key Words: Spreadsheet, Functions, Excel Add-in

greater is sufficient to observe differences among animals for ADG due to direct genetic effects under this environment.

Key Words: Gain, Heritabilities, Selection

296 Genetic parameter estimates for prolificacy, growth and wool characteristics of Rambouillet sheep. K. J. Hanford*¹, G. D. Snowder², and L. D. Van Vleck³, ¹University of Nebraska, Lincoln, NE, ²USDA, ARS, USSES, Dubois, ID, ³USDA, ARS, USMARC, Lincoln, NE.

Heritabilities and genetic correlations for prolificacy, growth and wool traits were estimated from Rambouillet data collected from 1950 to 1998 at the US Sheep Experiment Station, Dubois, ID. Number of records ranged from 39,816 to 44,211, 34,114 to 35,604, and 3,574 to 39,821 for prolificacy, growth and wool traits, respectively. Direct heritability estimates from single trait animal model analyses using REML were .09 for litter size at birth (LB), .06 for litter size at weaning (LW), .09 for litter weight weaned (LWW), .27 for birth weight (BW), .20 for weaning weight (WW), .16 for fleece grade (FG, visual spinning count), .51 for fleece weight (FW) and .58 for staple length (SL). Maternal heritability estimates were .19 for BW and .10 for WW. Estimates of genetic correlations among prolificacy traits were positive (.76 for LB-LW, .72 for LB-LWW, .95 for LW-LWW). Between BW and WW both the direct and maternal genetic correlations were positive (.60 for direct and .36 for maternal). FG was negatively correlated genetically with both FW (-.47) and SL (-.52); FW was positively correlated with SL (.46). Estimates of genetic correlations were low to moderate between BW and the prolificacy traits (.24, .00, .37 for LB, LW, and LWW) and moderate between WW and the prolificacy traits (.49, .56, .64 for LB, LW, and LWW). Estimated genetic correlations were small between fleece characteristics and prolificacy traits: for FW (-.08, -.04, .09), for FG (-.11, -.10, -.11) and for SL (-.16, -.04, -.07) with LB, LW and LWW, respectively. Growth traits were positively correlated genetically with FW (.21, .27 for BW and WW); negatively correlated with FG (-.15, -.14 for BW and WW) and positively correlated with SL (.14, .09 for BW and WW). These estimates can be used for multiple-trait, multi-flock genetic evaluations and for deriving selection indexes to optimize profitability of genetic selection.

Key Words: Heritabilities, Genetic Correlations, Selection

298 Helping the dairy producer make decisions 1: evaluating dairy herd production records. L. O. Ely*¹, J. W. Smith¹, W. D. Gilson¹, A. M. Chapa², C. Ramakrishnan¹, S. Chellapilla¹, and W. D. Potter¹, ¹University of Georgia, Athens, ²Mississippi State University, Starkville.

A web-based program, Dairy MAP(Dairy Management Analysis Program), has been developed to assist the dairy producer in the analysis of dairy herd production records and to help set priorities for areas of improvement. The system utilizes DHIA benchmark production parameter values which are specific for region and herd size. General herd information entered by the user includes herd size, state, SCC and component sampling options and percent AI sire usage. The DHI-202 herd summary report is the source of management data including rolling herd average production, summit milk, stage of lactation milk production, standardized milk and management information related to SCC, feed costs, reproduction and genetics. The first output table shows herd input values and percentile rankings of similar size herds in the same region. The percentile rank of the herd value is highlighted. The second output table compares herd inputs for summit milk, stage of lactation milk production and standardized milk to expected mean values by rolling herd average. Herd input values are highlighted by production level. More extensive analysis of SCC, production, genetics and reproduction are accessed in succeeding stages if the dairy producer wishes to proceed. Management input values are compared to expected mean levels by rolling herd average with deviations expressed as percentages. Output tables showing deviations from expected values as a series of asterisks ranging from 1 = poor to 6 = excellent assist in identifying areas for improvement.

Key Words: dairy management, decision making, web

299 Helping the dairy producer make decisions 2: an expert system makes recommendations. L. O. Ely*¹, J. W. Smith¹, W. D. Gilson¹, A. M. Chapa², C. Ramakrishnan¹, S. Chellapilla¹, and W. D. Potter¹, ¹University of Georgia, Athens, ²Mississippi State University, Starkville.

A dairy producer can analyze his dairy herd production records with a web-based program (Dairy MAP) and receive a list of areas for improvement. Often other information not available from the dairy herd production records must be utilized in order to make recommendations for improvement of the area under consideration. The second phase of Dairy MAP, a web-based expert system, will ask the dairy producer for additional information in order to make a recommendation. The expert system will have separate modules for SCC (Mastitis), Production, Genetics and Reproduction. Questions asked will partially depend upon previous analysis of dairy herd production records and the determination of areas of improvement. The SCC module is functioning and development of the other modules is on-going. The grouping of questions for SCC includes milking procedures, type of housing (milking herd, dry cow and/or heifers), cow groups, cleaning, treated cows, dry cow management and bacterial testing. For example, if the analysis of the dairy herd records shows that all cows had a high SCC in the first 40 days of lactation, the grouping of questions would begin with housing for dry cows and heifers, milking procedures and treatments. Recommendations could include dry cow treatment, a change of bedding, more frequent cleaning of housing, predipping or use of paper towels during milking depending on the answers given by the dairy producer. The questions and recommendations were developed by group of dairy scientists and veterinarians.

Key Words: dairy management, decision making, expert system

300 Dairy Farm Sustainability Check Sheet. C. A. Wells¹, J. A. Pennington*², D. W. Kellogg², D. E. Daniel², R. E. Morrow¹, W. K. Coblenz², D. Onks³, T. A. James⁴, C. Whiteside⁴, and R. Crawford⁵, ¹National Center for Appropriate Technology/Appropriate Technology Transfer for Rural Areas, ²University of Arkansas, Little Rock and Fayetteville, AR, ³Middle Tennessee Experiment Station, Franklin, TN, ⁴USDA-NRCS, Fayetteville and Harrison, AR, ⁵University of Missouri Southwest Research Center, Mt. Vernon, MO.

A dairy farm sustainability check sheet was developed as a joint effort by personnel from NCAT/ATTRA, the University of Arkansas Cooperative Extension Service and Experiment Station, NRCS, the Middle Tennessee Experiment Station, and local dairy producers. The objective in developing the check sheet was to produce an assessment tool which allowed producers to assess profitability and sustainability of their dairy operations plus environmental conditions and social impact of the dairy operations. Sections in the check sheet included an introduction, inventory of farm resources and management, sustainability, farm planning and goals, farm management (records, farm planning), facilities (livestock housing, milking parlor, calf raising, and other), livestock and forage program (herd health and reproductive management, breeding, genetics, selection program, and nutrition management), assessment of individual pastures, assessment of soils, assessment of watershed, nutrient management, alternative dairy farming (minor dairy species, seasonal dairies, and organic dairies), marketing, and summary. The dairy farm check sheet was initially patterned after a version of a beef farm sustainable check sheet and was revised following numerous dairy farm visits where representatives from each of the various agencies were present. Overall, the check sheet was designed to stimulate critical thinking when analyzing the dairy operation.

Key Words: Dairy, Sustainability, Check Sheet

301 The economic benefits of reducing age at first calving in dairy heifers. Barry Steevens*, R.L. Randle, Roger Bennett, D.K. Hardin, V.L. Pierce, and Joe Horner, *University of Missouri*.

Problem The Missouri dairy industry experiences a substantial annual loss due to extended age at first calving. This problem can be corrected or at a minimum reduced through management practices. However, these management practices may increase the cost of development of

these heifers. Producers need a methodology to evaluate their specific loss and potential gain from increased effort and expense in a modified management program.

Objectives The objective of this project is to identify and quantify the economic benefits to specific producers available to fund management programs necessary to reduce problems associated with extended age at first calving. These changes may include programs such as implementation of grouping and culling strategies that will provide for uniform groups to insure adequate access to feed.

Data and Methods Eight Missouri dairy producers were selected to participate in the project and submit data on their heifers. Schedules were developed and heifers were weighed, body condition scored and the wither height measured. In addition, udders and teats were evaluated for normality. The participating herds were evaluated every 8-10 weeks. The growth data collected from the participating farms was compared to industry benchmarks derived from the scientific literature. The cumulative growth data for all participating herds is compared to the benchmarks and used as a baseline in developing a profile of potential economic gains from reducing age at first calving. There were 1008 records collected in the program and used to develop the economic profiles in the participating herds. Enterprise budgets coupled with partial budgets were used to estimate potential gains from management changes.

Conclusion: Minimum requirements for weight and height were established according to the guidelines mentioned above from the scientific literature. Heifers were categorized by age and evaluated to determine whether minimum weight requirements were met. As few as 35.5 percent of the heifers at 12 months of age met the standard for weight. The decision tool reports the benefit to a specific producer in managing heifers to optimum age at first calving thus allowing for analysis of the costs and benefits of a management program designed to accomplish this improvement.

Key Words: Dairy Heifer, Economics, Calving

302 The Dairy Employee Education Program of the Michigan State University Extension Dairy Team. D. J. Bolinger*, C. S. Mooney, D. K. Beede, and H. F. Bucholtz, *Michigan State University, East Lansing, MI*.

The Dairy Employee Education Program was developed by the Michigan State University Extension Dairy Team with a grant from Michigan State University. The mission of the Dairy Employee Education Program is to strengthen the Michigan dairy industry by improving the husbandry and management proficiency of employees currently working on Michigan dairy farms. Program instruction emphasizes technical skill training of people not traditionally targeted by extension programs. The Program consists of nine educational modules that target the employee who works directly with the cows. The nine modules are: Feeder Training Program, Milker Training Program, Breeder Training Program, Introduction to Management Skills, Herd Health Skills for Calves and Cows, Heifer and Dry Cow Skills, Milking Herd Skills, Calf Care School, and Hoof Health Clinic. There also is an informational program for employers that discusses "Value Added Employees" and advertises the Dairy Employee Education Program. Students are taught practical skills and technical concepts during one or two day modules. Generally, the morning portion of the programs is lecture and the afternoon portion is laboratory. These modules are hosted by local Extension Dairy Agents and are team-taught by dairy agents, university faculty, and local industry personnel. From the Dairy Employee Education Programs beginning in 1998 through mid-February 2001, 28 modules have been presented across Michigan. Data from 24 of the sites shows a combined participation with limited duplication of 311 dairy farm employees representing 193 dairy farms and 52,260 cows. Dairy Employee Education Program schools, clinics, workshops have been credited with providing employees with the information and skills to not only maintain, but improve animal performance and profitability on their respective farms. Participants and their supervisors also report improved worker morale.

Key Words: extension, education, employee

303 The importance of best management practices and quality assurance programs in development of animal production food safety training/teaching modules. G.M. Jones*¹, B.R. Eastwood², M. Opperman³, and J.M. Mattison³, ¹Virginia Tech, Blacksburg, VA, ²USDA/CSREES, Washington, DC, ³The ADDS Center, Verona, WI.

A set of teaching and training modules in animal production food safety has been developed for training Cooperative Extension System field staff and for their use with animal producers. The project's steering committee of Extension specialists and agents recommended that the modules emphasize management practices known to enhance food safety and then highlight the various commodity quality assurance programs. Since HACCP provides the basis for most animal commodity quality assurance programs, one module describes HACCP compatible practices and why they are important to producing a competitive and safe food animal. These practices include: animal or premise identification, record keeping, residue avoidance, zoonotic and human pathogen disease prevention, maintenance of good sanitation practices in food animal production, and certification or verification by a third party. The modules elucidate good animal production and culling practices that prevent zoonotic and other animal diseases from entering the food supply and promote food safety. The module on best management practices describes sources of hazards and stressors, animal health (immune system, nutrition, environment), management precautions, risk assessment, and pathogen reduction. Another module shows the relationship between animal feedstuffs and food safety: contaminated feed, importance of feed quality, quality assurance in feed mill, biological agents transmitted by feed, and aflatoxin. The value of farm advisory teams and why's, who's, and how's of forming and utilizing effective teams to advise farmers/producers of management practices or problem-solving specific to that operation is explained. There is a description of quality assurance certification programs and why it is advantageous for producers to adopt one. Information is provided for the following commodity quality assurance programs: beef, dairy, pork, sheep, goats, veal, chick and poultry, egg, turkey, and aquaculture.

Key Words: Animal Production Food Safety, Management Practices, Quality Assurance Programs

304 Frequency of the porcine stress gene in show pigs and its effects on meat quality. J.A. Sterle*, C.L. Skaggs, and D.B. Griffin, Texas A&M University, College Station, Texas.

Class winning barrows (n = 97) from two major stock shows in Texas (eligible for the carcass contest) were tested for the presence of the porcine stress gene. Carcass variables such as backfat thickness, loin eye area, muscle pH and Hunter color values were also recorded. The primary objective of this study was to determine the frequency of the porcine stress gene in this population of heavily muscled, extremely lean show barrows. An additional objective was to evaluate the effects of this gene on meat quality. Blood was collected at exsanguination and shipped to a laboratory for analysis. Animals were classified at each show as Berkshire (B), Duroc (D), Hampshire (H), Yorkshire (Y), Poland China/Spot (PCS), Chester White/Landrace (CWL) or crossbred (XB). Frequency of normal (NN), heterozygous (Nn) and stress positive (nn) genotypes were 52.58%, 42.27% and 5.15%, respectively. Heterozygous animals were found in every breed. Genotypes by breed were: B barrows: 3 NN, 1 Nn, 2 nn; CWL: 5 NN, 5 Nn, 0 nn; D: 11 NN, 7 Nn, 0 nn; H: 7 NN, 9 Nn, 0 nn; PCS: 0 NN, 9 Nn, 3 nn; Y: 10 NN, 1 Nn, 0 nn; XB: 15 NN, 9 Nn, 0 nn. Each genotype was represented in B barrows, while every PCS barrow possessed at least one copy of the stress gene (no normals). Average loin eye area was 7.40 sq. in. and average 10th rib backfat thickness was 0.52 in. Hunter a values were 6.73 0.54, 6.00 0.38, 6.52 0.29, 7.81 0.30, 7.86 0.40, 7.98 0.63, and 7.74 0.26 for B, CWL, D, H, PCS, Y and XB barrows, respectively (P = .03). Loin muscle pH values were 5.63 0.04, 5.66 0.03, 5.72 0.02, 5.54 0.02, 5.66 0.03, 5.60 0.05, and 5.58 0.02 for B, CWL, D, H, PCS, Y and XB barrows, respectively (P = .03). Correlations between genotype and Hunter a values were .11, and between genotype and muscle pH were .003. Additional samples will be taken in subsequent years to analyze trends in the frequency of this gene. These results will be utilized to educate youth and adults involved in the show pig industry about the porcine stress gene.

Key Words: porcine stress gene, meat quality, PSS

305 Outreach video - Avian Influenza: Preventing the spread of disease. P. H. Patterson*¹, D. C. Kradel¹, R. M. Hulet¹, and J. H. Schwartz², ¹Penn State University, University Park, PA, ²York County Cooperative Extension, York PA.

Between 1983-1997 there were three introductions of Avian Influenza (AI) in Pennsylvania with the spread of disease resulting in depopulation of over 18 million birds. These experiences established the inseparable link between production flocks and the live bird markets (LBM) of NY and NJ, with these markets serving as a constant reservoir of AI viruses. AI has the potential to become highly pathogenic, devastating a poultry industry, disrupting national and international trade, and becoming a real or perceived threat to public health. The public health issue was highly publicized in 1997 when an H5N1 strain of AI found in the Hong Kong LBM caused human illness and several deaths. For these reasons it is essential that all concerned with the poultry industry understand the risks of AI and what might be done to reduce such risks. Therefore, a grant was submitted for USDA/CSREES Smith-Lever Special Needs funds for emergency situations within a state or region, and awarded in 1998. The objectives of the grant were to: 1. Increase awareness and understanding of the potential seriousness of AI to a state or regions poultry industry, and the real or perceived risk to public health. 2. Develop educational tools, and 3. Encourage procedures, testing and other actions necessary to participate in an AI prevention program. The ultimate goal is to break the cycle of AI infection within the poultry LBM and production facilities. Every effort should be made to reduce the risks of LBM interactions with the larger commercial poultry industry. A 25-minute video was produced documenting: 1. Details about the virus that causes AI. 2. The importance of keeping AI out of flocks. 3. Some of the signs or changes seen in birds with AI. 4. Common diagnostic laboratory tests for AI, and 5. Important steps that can be taken to prevent AI. The video is being distributed as part of the Mid-Atlantic Cooperative Extension (MACE) Poultry Health and Management Units biosecurity training efforts in the region. MACE members are partnering with the USDA/APHIS Live Bird Market Working Group in an education campaign with poultry growers, dealers, haulers, and markets, as well as city government and the press in efforts to break the cycle of AI infection between the LBM and production facilities.

Key Words: Avian Influenza, Video, USDA/CSREES Special Needs funds

306 Urban peafowl: the Rancho Palos Verdes Peninsula pattern. F.A. Bradley* and C.V. Gallagher, University of California, Davis.

The Blue Peacock (*Pavo cristatus*) has long been an introduced fixture on American estates and the sprawling ranchos of the west. With the demise of the birds' original owners and subdivision of the large properties, uncontrolled flocks started to roam. The Palos Verdes Peninsula covers roughly 22,000 acres south of Santa Monica Bay and north of San Pedro Bay in Southern California. In 1999 the City of Rancho Palos Verdes (PVE) entered into an agreement with the University of California at Davis (UCD). UCD staff were to assess the peafowl population in RPV and develop a management plan. Our research documents the advent and spread of peafowl on the peninsula. Frank A. Vanderlip, Sr. was one of the first developers of the peninsula. He acquired the peninsula's first peafowl (6-16) during the period between 1913 and 1937. The peafowl were managed, along with an extensive avian collection, on his estate within RPV. By 1960, the peafowl were roaming off the estate's northern edge and into Johns Canyon. Between 1960 and 1965 some of the peafowl were introduced into Palos Verdes Estates (PVE) by the City's mayor. By 1974 PVE birds had crossed the municipal boundary into the RPV neighborhood of Vista Grande. Residents of the RPV community of Portuguese Bend, report that the Vanderlip estate peafowl first moved from the estate south into Portuguese Bend in 1978. By 1988 peafowl were visible in the Crestridge region of RPV, having spread from adjacent Johns Canyon. PVE realized that they had a peafowl problem and in 1982 adopted a management plan. The plan has met with many difficulties and has not been successful. Our surveys documented 157 peafowl on the peninsula and the spread of peafowl off the peninsula and into San Pedro. No one claims ownership of the birds, therefore, they are constantly trespassing or traversing public property and thoroughfares. Extensive property damage, including damaged roofs, autos, and landscaping, is caused by the peafowl. Their chilling loud calls disrupt otherwise tranquil communities. A management plan that includes ongoing trapping and relocation by all the peninsula communities has

been presented. As more large ranches and rural properties are subdivided, the problem of uncontrolled flocks of domestic fowl will repeat itself.

Key Words: Peafowl, Rancho Palos Verdes

307 Women's participation in livestock production in Bangladesh: Proshika Experience. Md. Nuru Miah and Md. Nuru Miah, *Proshika Manobik Unnayan Kendra.*

Women's participation in livestock production in Bangladesh: Proshika Experience * Md. Nuru Miah
Livestock provides an employment and income generation opportunity for the poor. Women are traditional rearers of cattle and poultry in Bangladesh and possess most of the livestock population in the rural areas. The ownership per household of cattle, goat and poultry are 1.6, 1.03 and 6.8 respectively. Proshika, a national largest Non Govt. Organization (NGO) in Bangladesh has been operating a comprehensive livestock development programme consisting of milch cow, beef cattle, heifer/calf, sheep/goat, commercial poultry (layer and broiler), duckery production through direct participation of about 0.3 million women beneficiaries who are landless, destitute and divorced. The goal of the programme is to increase the productivity of poor's livestock resources

ASAS/ADSA Production, Management, and Environment: Temperature Effects, Production Schemes, and Housing Influence

308 Effect of summer water application on mound microclimate, performance, and body temperature of feedlot steers. M. S. Davis*¹ and T. L. Mader¹, ¹*University of Nebraska, Northeast Research and Extension Center, Concord.*

Ninety-six Bos taurus (Angus, Angus x Charolais) steers (avg. BW = 477 ± 3 kg) were randomly assigned to one of twelve pens to which one of three treatments (TRT; 4 pens/TRT) were applied: no water application (CON), water applied between 1000–1200 h (AM) and 1400–1600 h (PM). Water was applied via ground (mound) sprinklers when predicted average temperature-humidity index ≥ 74. Water flow rate (34 l/hd/d) and area sprinkled (2.4 m²/hd/d) were controlled using an inline meter and valves. On days 30–33, thermistors attached to data loggers recorded hourly tympanic temperature (TT). Concurrent with TT, temperatures were recorded 1 cm below the surface (Ts) and .15 and 1.52 m above the mound. Relative humidity was recorded at .15 and 1.52 m. Water (WI) and DMI were recorded daily and BW was recorded on days 0, 34 and 82 (termination of trial). Panting (0 = normal, 2 = heavy panting) and bunk scores (0 = ≤ 10% feed remaining, 2 = ≥ 50% remaining) were assigned to individual animals and pens, respectively at bi-hourly intervals from 900–2100 h under thermoneutral (avg THI ≤ 74) and hot environmental conditions (avg. THI ≥ 74) accompanied by sprinkling. Sprinkling did not affect BW, ADG or DMI, however feed efficiencies of AM steers were greater (P ≤ .10) than PM steers from days 34–82 (.190 vs .178 ± .004) and 0–82 (.180 vs .168 ± .004). Day 0–34 WI was greater (P ≤ .01) in AM vs PM steers (38.29 vs 35.29 ± .21 l/d). During water application, Ts was higher (P ≤ .05) for CON vs AM and PM mounds at all times, with PM mounds lower (P ≤ .05) than AM at 730 and 1500–2000 h. Tympanic temperature of AM steers was lower (P ≤ .05) than CON and PM steers from 800–900 and 2300–700 h, and lower than PM steers from 1200–1300 h. From 1600–1900 h, PM steers had lower (P ≤ .05) TT than CON, with AM intermediate. Sprinkling feedlot pens under hot environmental conditions lowers TT and mound temperatures. Morning water application maximized animal efficiency relative to afternoon application.

Key Words: sprinkling, microclimate, feedlot

309 An evaluation of different types of commercial fans with or without misters in cooling high producing cows in the summer months in the sub-tropics. CN Lee*¹ and KS Baek^{1,2}, ¹*University of Hawaii-Manoa, Honolulu, HI 96822,* ²*National Livestock Research Institute, Namwon, S.Korea.*

In Hawaii, data collected from dairies on Oahu showed that when THI increases milk production decreases. The THI can exceed 81 in the hot months. Milk production could decrease by 25% with in high production herds and by 10% in low production herds. However, the use of fans and misters could alleviate this summer slump. This

which contributes substantially to poverty alleviation efforts by raising their income. Extension support like vaccination, deworming, treatment, artificial insemination, fodder production is provided to the involved farmers through well trained vaccinators, paravets, artificial inseminators etc. belong to Proshika target groups. Technical training of farmers on particular skill, credit, follow-up, monitoring and marketing support is provided from Proshika through its 950 technical workers. A central team of 17 livestock experts are providing planning, technical guidance & supervision of the programme. Five poultry breeder's farm alongwith five hatcheries and feed mills are in operation to supply 100000 day old chicks and 80 MT. feed weekly to the beneficiaries. Adaptive research activities are implemented at the farmers level to disseminate appropriate technologies on livestock. The impact of these activities showed that mortality reduced from 10 percent to 3.5 percent incase of cattle and from 20 percent to 5–8 percent incase of poultry in the project areas, farmers have been able to raise their income by 150 percent through livestock raising, women's status increased in the family and society.

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Key Words: Milch cow, Duckery, NGOs

study evaluated the efficacy of 4 types of fans with/out misters in cooling cows under heat stress :- Gp.A-Korral-Kool(2hp)+Schaffer fan (n=111), Gp.B-Universal Foggers(1hp)(n=144), Gp.C-Universal Foggers(1.5hp)(n=135)and Gp.D-Schaefer fan(1/2hp) w/o misters(n=103). Cows were housed in open lot under shade. Temperature and humidity readings were taken prior to the start of monitoring respiration rate (RR) and at the end of the each collection period not exceeding 30 min. The avg. THI(n=16) were 77 for am and 78 for pm. No differences in mean RR were observed in Gp. A, B, and C in am; 66.7, 65.2, 63.8 respectively. Gp.D had higher RR, 73.3(p<0.05). Higher RR were observed in pm period for Gp. A,B,C but there were not different between groups; 76.1, 72.7, 73.9. Gp.D had RR of 88.0 (p<0.05). The avg. wind speed (kmh) at 4.8m from the fan and 76 cm from the ground for Gp.A,B,C,D were 3.8, 4.2, 6.3, 4.9 respectively. The data suggest that wind speed and misters are important to cool cows. Milk production slump was alleviated in Gp.A,B and C. Energy cost per fan was evaluated.

Key Words: Respiration rate, Heat stress, Milk production

310 Impact of Fan Location upon Milk Production, Feed Intake and Respiration Rates of Lactating Dairy Cattle Housed in a 4-row Freestall Barn. M.J. Brouk*, J.F. Smith, and J.P. Harner,III, *Kansas State University.*

One hundred mid-lactation Holstein cows averaging 173 DIM and producing 44.25 kg/c/d of milk were blocked by milk production and DIM and randomly assigned to one of 4 pens of a 4-row freestall barn. Two replicates, north and south halves of the barn, contained 2 pens each. Fan treatments were 91.4 cm fans mounted every 6.1 m on the feed line (F) or 91.4 cm fans mounted every 6.1 m on the feed line and over the center of the head-to-head freestalls (F&S). All pens were equipped with feed line sprinklers that operated on a 15 min cycle (3 on and 12 off) when temperatures were above 23.8°C. All fans operated when the temperature was above 21.1°C. A switch back design with 5 two-wk periods was utilized to evaluate fan placement. Cows and treatments were switched at the start of each period within each replicate. Cows were milked 2x and milk production was measured every two weeks throughout the 10 wk trial. All pens received the same diet. Amounts of feeds offered and refused were measured and recorded daily. Dry matter content of the diet and refusal of each was determined twice weekly. Cow respiration rates were measured on three separate days under heat stress. Fifteen cows were randomly selected from the 25 study cows in each pen and respiration rates were measured in the morning (0700–0800 hr), afternoon (1500–1600 hr) and at night (2200–2300 hr) on each of the three days. Cows exposed to treatment FS produced more (P<.01) milk (38.8 vs 36.2 kg/c/d) during the trial than those exposed to the F treatment. Respiration rates were lower (P<.06) in the morning (71.7 vs 79.3

breaths/c/m), at night (76.0 vs 80.1) and daily (79.4 vs 83.2) under the FS treatment compared to the F treatment. Afternoon respiration rates were unaffected by treatment. This study clearly demonstrated that in a 4-row freestall barn greater milk production and a lower respiration rate was obtained by locating fans on both the feed line and over the freestalls. Based on respiration rates, the duration of heat stress was reduced by the FS treatment demonstrated by lower respiration rates in the morning and at night. Appropriate fan location in combination with feed line sprinklers reduced heat stress in lactating dairy cattle housed in a 4-row freestall building.

Key Words: Heat stress, Facilities, Dairy cattle

311 Evaluation of Heat Stress in 4- and 6-Row Freestall Buildings Located in Northwest Iowa. J.F. Smith*, M.J. Brouk, and J.P. Harner, III, *Kansas State University*.

The objective of this trial was to evaluate the effect of 4- and 6-row freestall barns located in Northwest Iowa on barn temperature, humidity, and THI. In addition, respiration rates of lactating Holstein cows were also evaluated. Six freestall barns (three, 4-row and three, 6-row barns) with east-west orientation located on five dairies were utilized in this experiment. Temperature and humidity readings were collected at four locations near cow level in each barn. Ambient temperature and humidity were collected at two locations in close proximity to each freestall barn. Temperature and humidity data were collected continuously at 15 minute intervals from June 9 until September 27, 2000 using HOBO® data loggers. Respiration rates were collected in the morning (06:00-08:00) and afternoon (14:00-16:00) on three different days during August 2000. During each observation period respiration rates were collected from 50 cows, 25 from the north and 25 from south half of each barn. For data analysis, the 25 data points from each of the halves of the barn were averaged by day and observation period. Temperature and humidity data were averaged by 3-hr periods for each day. Data were then analyzed as a replicated single factor experiment with 4-row and 6-row barn as the treatments. Statistical differences were detected ($P < .05$) in difference between ambient and barn conditions with respect to temperature, relative humidity and THI. On the days respiration rates were measured, 6-row barns as compared to ambient conditions were .25° C warmer ($P < .01$), had less ($P < .01$) humidity (.69 %) and greater ($P < .01$) THI (.45) than 4-row barns. Respiration rates were higher ($P < .05$) in 6-row vs. 4-row freestall barns in the morning (65.8 vs. 60.5 breaths/c/m), afternoon (78.4 vs. 73.8) and daily average (72.1 vs. 67.2). Although statistical differences exist in differences between ambient and barn temperature and THI, the magnitude of these differences may not explain the differences detected in respiration rates. It is possible that increasing animal density may change the relationship between social interaction and animal density. It could also be possible that additional mechanical ventilation may be required to keep cows comfortable in 6-row barns.

Key Words: Heat stress, Facilities, Dairy cattle

312 Influence of Freestall Barn Orientation upon Summer Heat Stress in Lactating Dairy Cattle. J.F. Smith*, M.J. Brouk, and J.P. Harner, III, *Kansas State University*.

The objective of this trial was to evaluate the effect of freestall barn orientation (North-South (NS) vs. East-West (EW)) of 4-row freestall barns located near Tulare, California on barn temperature, humidity, and THI. Effects on respiration rates of lactating Holstein cows were also evaluated. Six freestall barns (three NS and three EW barns) on six dairies were utilized in this experiment. Temperature and humidity readings were collected at four locations in each barn. Ambient temperature and humidity were collected at two locations in close proximity to each freestall barn. Temperature and humidity data were collected continuously every 15 minutes from April through August 2000 using HOBO® data loggers. Respiration rates of lactating dairy cattle were collected in the morning (06:00-07:00) and afternoon (15:00-16:00) on three different days during August 2000. During each observation period, respiration rates were collected from 50 cows, 25 from each half of each barn. Individual data points were averaged by day, barn and observation period for analysis. Temperature and humidity data were averaged daily by 3-hr periods. Data collected were analyzed as a replicated single factor experiment with barn orientation (E/W and N/S) as the treatments. The difference between barn and ambient conditions showed that NS barns were .24° C cooler ($P < .01$), humidity .44%

greater ($P < .01$) and THI .26 less ($P < .01$) as compared to EW barns during August 2000. Respiration rates were greater ($P < .05$) in NS vs. EW orientated barns in the morning (56.4 vs. 52.2, breaths/c/m), afternoon (77.4 vs. 68.8) and daily averages (66.9 vs. 60.5). The differences of barn temperature and humidity did not appear to explain differences in respiration rates between the two different types of barn orientation studied. Other factors including exposure to solar radiation, airflow, and animal stress may have contributed to the differences observed in respiration rates.

Key Words: Heat stress, Facilities, Dairy cattle

313 Influence of Headlocks upon Summertime Milk Production and Feed Intake of Lactating Dairy Cattle Housed in 2-row Freestall Barns. M.J. Brouk*, J.F. Smith, and J.P. Harner, III, *Kansas State University*.

Two hundred sixteen Holstein cows in mid-lactation (110 primiparous, averaging 189 DIM and 38.7 kg/c/d milk; and 106 multiparous, averaging 178 DIM and 42.0 kg/c/d milk) were blocked by lactation DIM and production and allotted to two 108 cow 2-row freestall barns. Both barns were equipped with similar equipment and heat abatement systems. A switchback design with two 4 wk periods was utilized to evaluate the effects of headlocks upon milk production and feed intake. Feed line barrier treatments were either standard headlocks (H) or a post and rail (P&R). Treatments were physically switched between barns at the beginning of the second period. Cows were milked 3x and milk production data was captured electronically every milking throughout the trial. Amounts fed and refused were measured and recorded daily. Dry matter content of the diet and refusal was determined twice weekly and daily pen dry matter intakes were determined. Daily milk production and pen dry matter intakes were averaged by pen and week for data analysis. Milk production (35.2 vs 34.7 kg/c/d respectively for H and P&R) was not affected ($P = .16$) by treatment. Primiparous cattle averaged 34.6 kg/c/day of milk when exposed to H versus 34.3 kg/c/d when exposed to P&R. Multiparous cattle averaged 35.7 kg/c/d when exposed to H versus 35.2 kg/c/d when exposed to P&R. While primiparous cattle produced ($P < .01$) less milk than multiparous cattle neither group was affected ($P = .25$) by treatment. Pen dry matter intakes were also unaffected ($P = .08$) by treatment (22.8 vs 23.5 kg/c/d). The use of headlocks did not result in a decrease in feed intake or milk production of primiparous and multiparous cattle in this study. Cattle in this study were previously exposed to headlocks, thus the effects of headlocks upon untrained cattle was not determined. With trained cattle, removal of headlocks did not increase milk production or feed intake. Results of this study showed that headlocks could be used effectively without negatively impacting the performance of lactating dairy cattle.

Key Words: Heat stress, Facilities, Dairy cattle

314 Influence of ambient temperature, humidity and bovine somatotropin (bST) on reproductive performance of postpartum Holstein cows. R. Flores*¹, M. L. Looper¹, J. J. DeRuyter², D. M. Hallford¹, and M. G. Thomas¹, ¹New Mexico State University, Las Cruces, New Mexico, ²Mountain View Dairy, Mesquite, New Mexico.

Seventy-nine estrous cycles of multiparous Holstein cows ($n = 44$) during May to August were evaluated for the effects of ambient temperature, humidity and bST on reproductive performance. At 60 to 75 d in milk (DIM), all cows were fitted with a HeatWatch (DDx Inc., Denver, CO) transmitter and estrous activity was recorded. Cows were randomly assigned to treatment with bST (Monsanto Co., St. Louis, MO; 500 mg, s.c., every 14 d) or without (nbST) beginning at 80 DIM. Milk yield (kg), DIM and body condition score were 42 ± 1.6 , 69 ± 1.5 and 2.8 ± 0.1 for bST cows and 41 ± 2.3 , 72 ± 1.6 and 2.8 ± 0.2 for nbST cows, respectively. Weekly plasma samples were collected and concentrations of progesterone were quantified. Maximum ambient temperatures and relative humidity were recorded daily and a temperature-humidity index (THI) was calculated for the day of estrous onset. Range of THI was 68 to 80. Duration of estrus, number of mounts and quiescent periods between mounts were similar ($P > 0.10$) between treatments. Mean duration of estrus was 6.0 ± 0.7 h for bST cows and 6.2 ± 0.9 h for nbST cows. Mean number of mounts was 10.0 ± 1.0 and 8.0 ± 1.2 for bST and nbST cows, respectively. Quiescent periods between mounts averaged 2.7 ± 0.4 and 2.5 ± 0.5 for bST and nbST cows, respectively. Duration of estrus and number of mounts were not influenced ($P > 0.10$)

by THI. Quiescent periods observed between mounts tended ($P = 0.10$) to be influenced by THI and were 1.7 ± 0.5 , 3.0 ± 0.4 and 3.2 ± 0.5 h for THI 1 (< 74), THI 2 (74 to 77) and THI 3 (>77), respectively. First service conception rates were not influenced by treatment or THI. First service conception rates for bST and nbST cows were 31 and 23%, respectively. Pregnancy rates tended ($P = 0.13$) to be affected by THI. Pregnancy rates were 66, 28 and 35% for THI 1, THI 2 and THI 3, respectively. Treatment of postpartum cows with bST during mild heat stress did not alter estrous characteristics. Time of quiescence between mounts was increased and pregnancy rates were decreased as THI elevated. Reproductive performance of postpartum cows was reduced by increased temperatures and humidity.

Key Words: Estrus, Somatotropin, Temperature-Humidity Index

315 Getting a handle on costs of production: a quick and easy method for dairy producers. D. Shoemaker* and J. Polson, *The Ohio State University, Wooster, Ohio.*

All dairymen who will be competitive in the U.S. dairy industry must make decisions for their businesses based on the expected impacts of the decisions they make on both milk production and cost of production. Most Ohio dairy farms have not used cost of production information in their regular decision making processes. Additionally, new opportunities are now available to put a floor under or set a dairy farm's milk prices. Dairy farm managers who do not know their costs of production may make inappropriate decisions. Once a dairy farmer calculates their cost of production and integrates known costs into the decision making process, he can begin to fine tune the process of record keeping and cost and return calculations.

A quick and easy worksheet for calculating a farm's historical cost of production and a projected, long-term planning price for milk was developed to help farmers use typical Midwest financial record information in making daily decisions. Six dairy farms, ranging from 65 to 350 cows, were used to pilot the worksheet. These farms' long term planning prices for milk ranged from \$12.50 to \$16.02 per cwt. based on 1999 data. This price would cover the short term costs of producing milk, principal payments, a return to the operator, reinvestment in the business and income taxes. The process for calculating this information was then incorporated into Extension teaching efforts.

Key Words: Cost of production, Long term planning price, Planning

316 Comparing dairy herd information with a dynamic web-based tool called DairyMetrics. C.N. Vierhout*¹ and J.S. Clay¹, ¹*Dairy Records Management Systems, North Carolina State University, Raleigh.*

DairyMetrics is benchmarking software for dairy herd performance evaluation. It allows users to select information that will be displayed about an individual herd in comparison to cohort herds. Individual producers, commercial consultants or extension personnel can compare an individual herd to cohorts or analyze an entire group of herds. This web application allows users to select cohorts based on their individual parameters within the classifications of general, production, udder health, reproduction and genetic information. Within the five classes of parameters, there are 76 variables from which to choose. The underlying database includes herd summary information from almost 14,000 herds that are routinely processed by Dairy Records Management Systems. The database is updated nightly to maintain current herd information. DairyMetrics displays information about the specified herd plus the means, standard deviations, minimums and maximums for the cohort herds. It also presents the percentiles for each herd performance parameter in comparison to the cohort group. Users have the option of graphing their herd and its cohorts for the previous 3 months and from data 1-year prior.

Key Words: DairyMetrics, benchmarking, dairy management

317 Developing Six Sigma Quality Management Programs for Dairy Farms. T.P. Tylutki* and D.G. Fox, *Cornell University, Ithaca NY.*

As margins and environmental pressure forces dairy producers and nutritionists to decrease safety factors and nutrient excretion, the potential for animal production variability increases. A robust quality management program is required that will identify and control the variance

sources that result in animal production variability. Attempts have been made utilizing total quality management principles; however adoption rates have tended to be low. Six Sigma is the current quality paradigm with the objectives of: 1.) Business transformation, 2.) Strategic improvement within the business, and 3.) Problem solving. Six sigma combines human resource management, quality control, and quality planning.

The feeding system on a case study farm has been used to develop and implement a six sigma quality management program. Sources of variation were identified (feed dry matter, feed chemical composition, feeder accuracy, mixing and delivery, etc.) and data collected to determine within farm variances for feed dry matter and chemical composition (Table 1). Feed variance results were used to develop a sample frequency schedule based on a 95% confidence interval with varying levels of precision. The feeder has been receiving training in basic animal nutrition, developing quality control charts, and simple statistics. Several components of the feeding system have been targeted as weak points by this study including limitations in current software for feeding, unknown scale accuracy, rapid and reliable dry matter analysis, and training in root cause and statistical analysis. A quality management manual is being developed that will contain: standard operating procedures, feed sampling protocols, mixer reliability and reproducibility studies, control charts (development and interpretation), root cause analysis, record keeping (inventory, equipment service, and diet/weather changes), and professional development plans for staff.

Table 1. Composition of home grown feeds sampled at feeding.

	1998 corn silage	1999 corn silage	Grass	Alfalfa
Mean DM	27.72	31.02	30.75	35.10
DM CV %	6.4	9.1	28.4	23.2
Mean NDF (% DM)	50.46	44.76	59.75	46.67
NDF CV %	8.7	9.8	11.9	12.5

Key Words: Quality management, Six Sigma, Feed variance

318 Programmed exercise improved physical fitness of non-lactating, pregnant and non-pregnant dairy cows. J. A. Davidson*, R. R. Devins, and D. K. Beede, *Michigan State University, East Lansing.*

Objective was to determine the effects of a programmed exercise regimen (PER) and pregnancy of Holstein cows on physical fitness, acid-base status, and blood mineral element concentrations. Non-lactating, multiparous pregnant or non-pregnant cows ($n=52$) were blocked by parity and expected calving date and assigned randomly to treatments: no exercise or exercise at a walk (3.25 km/h) every other day for 1.25 h, d 0 to 30; and, 1.5 h, d 31 to calving (d 70 of PER) in a mechanical walker with a circular lane (33.8 m circumf.). All cows completed treadmill exercise tests (ET) on d 0, 30 and 60 of PER. Treadmill ET consisted of walking 4 km/h for 3 min followed by 5 km/h with incremental increases in incline every 3 min until cows refused to walk. Length of time to refusal during the ET was one indication of physical fitness. Jugular blood was sampled every 3 min during the ET and the 18 min recovery period (RP) after the ET. Physical fitness improved with the PER; exercised cows walked longer during the ET compared with non-exercised cows (21.6 vs. 18.7 min, $P<0.01$). Venous whole blood pH and concentrations of K were lower for exercised compared with non-exercised cows during ET ($P<0.05$). Concentrations of K, hematocrit (HCT) and pO_2 increased during ET as time increased whereas ionized Ca concentrations decreased ($P<0.05$). Normalized ionized Ca (nCa, pH adjusted) concentration during the d 60 ET was higher for exercised compared with non-exercised cows, and was higher for pregnant than non-pregnant cows ($P<0.06$). During ET, pCO_2 was lower for pregnant cows compared with non-pregnant cows and decreased as time increased ($P<0.06$). Concentrations of Na were higher for pregnant compared with non-pregnant cows during d 60 test ($P<0.01$). During RP, venous concentrations of Cl, Na, nCa, and pCO_2 increased as time increased whereas K, HCT and pO_2 decreased ($P<0.01$). However, the magnitude of changes were very small during the RP. The pH of venous blood during RP was lower for non-exercised cows compared with exercised cows ($P<0.10$). Blood volume was not affected by exercise. Pregnant cows had larger blood volumes than non-pregnant cows ($P<0.05$). A PER reduced changes of acid-base status and increased physical fitness of dairy

cows. Pregnancy altered blood volume, pCO₂, and concentrations of nCa and Na during the ET.

Key Words: Exercise, Pregnancy, Dairy Cows

319 Profit maximizing calving interval with limited labor resources. C. C. Risch* and C. A. Wolf, *Michigan State University.*

Many dairy farms consistently exceed the industry benchmark calving interval of 13 months, instead having calving intervals of 14 to 16 months. Previous literature typically supports the 13 month benchmark but does not consider resource constraints (e.g., labor, capital, feed) common to dairy farms. This study examines the profit-maximizing calving interval decision when the managerial and skilled labor are limited. An optimizing linear programming model that explicitly considers managerial and skilled labor constraints was developed to identify the calving interval that maximizes net returns to a dairy herd. The model considered 13 to 18 month calving intervals in terms of lactation stage distribution effects on net returns and labor use. Revenues and expenses associated with calving interval and included in the model are milk, calf and cull revenues, as well as replacement and herd health costs. The model allowed various labor allocations in meeting the herd health and reproductive requirements needed to maintain a given calving interval. Results indicate that, although a 13 month calving interval is associated with the highest revenues, the profit-maximizing calving interval for a farm varies significantly with both managerial and skilled labor constraints. Further, labor allocation across reproductive and herd health activities is crucial in determining the profit-maximizing calving interval. Data from a 200 cow herd was used in the model, which resulted in an optimal calving interval of 14 months, achieved with hired labor contributing substantially to heat detection and breeding activities. Labor skill level and wage rate contribute significantly to the optimal calving interval for a given herd.

Key Words: Calving interval, Labor constraint, Linear programming

320 Dry matter intake of lactating dairy cows housed in freestall barns. D.M. Allen*^{1,4}, J.G. Linn^{1,4}, K.A. Janni^{2,4}, and S.C. Stewart^{3,4}, ¹*Department of Animal Science*, ²*Department of Biosystems and Agricultural Engineering*, ³*Department of Clinical and Population Sciences, College of Veterinary Medicine*, ⁴*University of Minnesota.*

Data was collected from twenty groups of lactating dairy cows on three commercial farms from November 1999 to January 2001. All cows were housed in freestall barns. Groups for all three farms were managed based on stage of lactation, reproductive status and parity. Twelve groups had headlocks at the manger, 5 groups had rail-line feeding and 3 groups were fed in J-bunks. On average, 2075 lactating cows were represented in the milk and DM intake (DMI) data collected each month. Body condition score and body weight (BW) were determined on thirty-five percent of the cows in each group once per month. Feed DM offered each group daily was recorded using EZ Feed™ software. Weighbacks, corrected to a DM basis, were recorded from each group and subtracted from feed DM offered to determine DMI. Group means for milk production and days in milk (DIM) were recorded daily by DairyComp 305™. Bulk tank milk composition was recorded daily from each farm. Group means and standard deviations (SD), categorized by DIM and parity, for BW, milk, and DMI are reported. DMI was predicted using the NRC 2001 equation for DMI from group mean data. The difference between actual and predicted DMI within farm and category is similar to the

mean square prediction error reported for the DMI prediction equation in the NRC 2001.

	Farm A		Farm B		Farm C	
	Mean	SD	Mean	SD	Mean	SD
Lactating Cows/Farm	889		503		682	
Multiparous						
DIM 80 to 130						
Number of groups	2		1		2	
BW, kg	601.5	71.6	680.5	62.7	598.6	62.3
Milk, kg/d	45.2	4.8	52.1	2.8	42.2	7.3
DMI, kg/d	25.5	2.7	27.6	2.9	24.0	3.2
Predicted DMI, kg/d	26.9		30.2		25.7	
DIM 201 to 310						
Number of groups	3		1		2	
BW, kg	570.2	47.2	693.2	83.5	594.3	68.9
Milk, kg/d	32.2	2.0	33.9	2.9	31.3	5.8
DMI, kg/d	23.4	5.2	23.7	3.5	22.8	1.9
Predicted DMI, kg/d	22.5		24.7		22.6	
Primiparous						
DIM 80 to 130						
Number of groups	2		1		1	
BW, kg	530.8	61.7	581.9	64.7	514.0	46.8
Milk, kg/d	34.0	2.4	41.2	2.2	34.9	1.7
DMI, kg/d	19.9	3.9	23.1	2.5	19.5	1.5
Predicted DMI, kg/d	21.6		25.2		21.7	

Key Words: DMI, group, lactating dairy cows

321 Performance, health, and management of calves housed in a greenhouse barn (GHB) versus traditional wooden hutch (WH) during a Mississippi winter. M. L. Scott* and W. B. Tucker, *Mississippi State University, Mississippi State.*

The primary objective was to evaluate housing based upon management and health of young calves during wintry conditions. Forty dairy calves (32 Holstein; 8 Jersey) were randomly assigned at birth, blocked by breed and calving date, to a traditional WH or novel GHB (December 1997 to April 1998). Incidence and severity of scours, dietary intake, body weight changes, feed efficiency, respiration rate, rectal temperature, morbidity, and mortality were recorded from birth to 56 d. Calving assistance, Ig absorption, and calf vigor (birth to 1 h postpartum) were also recorded. Milk diet was 50% milk replacer (22% CP; 12% fat) and 50% waste milk. Gross energy were determined on daily samples composited by week. Dry feed (16% CP) was offered at 5d. Neither ADG (0.420±0.03, WH and 0.459±0.05 kg, GHB) nor feed efficiency (1.36±0.10, WH and 1.45±1.00 kg, GHB) were significantly different by housing. Weight gain was higher (P<0.05) for GHB than WH postweaning, 0.886±0.06 and 0.622±0.72 kg, respectively. Calves housed in WH consumed grain 1 wk earlier than GHB. Rectal temperatures at birth and overall were similar between housing. Fecal scores were 2.24±0.04 and 2.28±0.04 for WH and GHB, respectively. Observed health requiring medical attention were higher for GHB than WH (scours, respiratory and naval infection). Management and morbidity of GHB is similar to other barns. Nonetheless, GHB appears to be a suitable alternative to classical WH during winter, based upon growth.

Key Words: Greenhouse barn, Housing, Winter

ASAS/ADSA Ruminant Nutrition: Ruminal Fermentation

322 The effects of pH on acid resistance of cattle fecal *Escherichia coli* and O157:H7 in continuous culture or pure culture. C. J. Fu*, J. Porter, J. W. Lehmkuhler, E.E.D. Felton, D. Schmidt, M. Huck, and M.S. Kerley, *University of Missouri-Columbia, Columbia, MO 65211.*

Twelve single-phase continuous culture (CC) fermentors with a 0.045/hr dilution rate (D) and pure culture incubations were used to determine the effect of pH on acid resistance of fecal *E.Coli.* and *E.Coli.* O157:H7, respectively. The pH tested was 7.5, 7.0, and 6.5 in CC and 7.5, 7.0, 6.5, and 6.0 in pure culture. The basal diet fed to the CC was corn and

soybean meal (95% + 5% on DM basis). The CC fecal inoculants were combined from 20 feedlot steers. The microflora samples were taken from the CC after 96 h of growth. The media used for the pure culture incubations was tryptic soy broth (TSB) without dextrose. Tubes were inoculated with *E.Coli.* O157:H7 (ATCC 43895) and then sampled after 24 h of incubation. The viable *E.Coli.* was enumerated by multi-tube method using lauryl sulfate trypticase broth (LST) as media. The viability of fecal *E.Coli.* linearly (P < 0.01) decreased (3.5, 0.7, and 0.007%) after extreme acid shock (pH = 2, 1 h) as the culture pH increased in CC. No *E.Coli.* O157:H7 was found in CC. The O157:H7 pure cul-

ture study indicated that the viability of the organisms was higher ($P < 0.01$) after extreme acid shock (pH 2, 4 h) when cultivated in pH 6.0 media than that in the other pH media (9.0 vs 2.4, 2.5, and 2.5%). This study demonstrated that culture pH affected acid resistance of *E. Coli*. as previously hypothesized.

Key Words: *E. Coli.*, Acid resistance, Acid shock

323 Effect of sampling frequency and schedule when determining dietary effects on ruminal pH. K. M. Krause* and D. K. Combs, *University of Wisconsin-Madison*.

Ruminal pH is often used as a response variable when assessing fiber adequacy of dairy rations. The optimal number of samples and the best time to sample in order to detect possible differences in ruminal pH are not known. In order to investigate this question a replicated 4 x 4 Latin square study with two forage particle sizes and two levels of corn grain moisture was used as an example. Ruminal pH was measured continuously for a five day period using indwelling electrodes and cows were fed twice daily. Feeding the cows twice daily caused diurnal variations in pH, so effect of feeding was included in the model along with day and hours post feeding. Data were analyzed as repeated measurements using proc mixed. In this study significant effects of the main variables forage particle size ($P < 0.05$) and corn moisture ($P < 0.001$) on pH were found using continuous measurement of ruminal pH. Also, the two forage particle sizes ($P < 0.001$) and the two daily feedings ($P < 0.005$) affected the decline in pH post feeding differently. Six alternative sampling schedules were investigated: 1) 4 h post am feeding on one day, 2) every 4 h for 24 h, 3) every 2 h for 12 h post am feeding, 4) 4 h post am feeding for five days, 5) every 4 h for five days, and 6) every 2 h for 12 h post am feeding for five days. The different sampling scenarios were simulated by using only the data points specified above from the data set collected using the indwelling electrodes. If sampling only on one day, sampling schedule 3 was the only schedule which detected effects of both dietary variables on pH. Sampling just once daily, but over a five day period (schedule 4), detected only a forage particle size effect on pH. Both sampling schedule 5 and 6 detected significant effects of both dietary variables and also interaction effects between dietary factors and hours post feeding. Based on the current data it can be concluded that when sampling on just one day, taking several samples between feedings is more useful than sampling across feedings. However, in order to detect dietary effects and effects of feeding on diurnal fluctuations in pH, data has to be collected across feedings and across several days.

Key Words: Ruminal pH, Sampling schedule

324 Effects of propionate supply on plasma vitamin B12 in growing lambs. CL Girard*¹, L Majdoub², and I Ortigues², ¹*Dairy and Swine R&D Centre, Agriculture and Agri-Food Canada, Lennoxville, Canada*, ²*INRA, Unite de Recherches sur les Herbivores, Nutriments et Metabolismes, Theix, France*.

In sheep, up to 50% of glucose comes from propionate (Kennedy et al.1994. *Internat.J.Vit.Res.*64:270). Methylmalonyl-CoA mutase, a key enzyme in this metabolic pathway, requires vitamin B12 as a coenzyme. A lack of vitamin B12 induced by cobalt deficiency impaired propionate metabolism in sheep (Smith and Marston.1971.*Br.J.Nutr.*26: 41; Kennedy et al.1991.*Biol.Trace Element Res.*28:233). Within the framework of 2 trials aiming to study the influence of an additional supply of propionate on nutrient partition among tissues, the present work was undertaken to determine if changes in propionate supply modify vitamin B12 status in growing lambs. Four male lambs (32 ± 2.2 kgBW) were fed frozen rye-grass (cut at grazing stage, chopped in 5cm length, frozen at -35°C and stored at -15°C) at an estimated level of 165 kcal ME per kg BW^{0.75} in 12 equal meals daily. The treatments were applied in a cross-over design. In Trial 1, they consisted of 5d continuous intraruminal infusion of saline (C) or propionic acid representing 10% (P1; 0.54 mole propionate/d) or 16% (P2; 0.97 mole propionate/d) of daily ME intake from rye-grass, separated by transition periods of 7d. In Trial 2, the lambs were fed during 2wk the same basal diet than in Trial 1 supplemented or not with barley to increase the estimated absorption of propionate by 0.56 mole/d. At the end of each treatment period, blood samples were taken at 30min intervals during 4h for determination of vitamin B12 in arterial plasma. In Trial 1, plasma vitamin B12 decreased when propionate supply increased ($P = 0.07$); 432.9 ± 69.1 , 236.9 ± 33.4 and 276.8 ± 68.7 pg/ml for C, P1 and P2, respectively. In Trial 2, feeding grass+barley decreased plasma vitamin B12 (551.9 ± 87.5 pg/ml) as compared to grass alone (851.5 ± 173 pg/ml) ($P = 0.08$). Therefore, it seems

that increasing propionate supply decreased drastically plasma vitamin B12, probably through an increased demand for vitamin B12 by tissues involved in propionate metabolism.

Key Words: Vitamin B12, Propionate, Lamb

325 Assessment of phosphorus availability from different sources for ruminal fermentation. V. Fellner*, J. W. Spears, and S. J. McLeod, *North Carolina State University, Raleigh, NC*.

Two experiments were conducted using continuous cultures to (1) study the phosphorus requirements of rumen microorganisms and (2) determine the availability of phosphorus from different sources. Diets consisted of cottonseed hulls, corn starch, urea and an amino acid mixture. In the first experiment ($n=2$) daily additions of 28.3, 19.0, 9.4 and 0 mg of inorganic phosphorus (Pi) supplied as sodium phosphate resulted in culture soluble Pi concentrations of 13.9, 13.6, 8.2 and 2.0 mg/l, respectively. At Pi concentrations of 13.9, 13.6 and 8.2 mg/l total volatile fatty acids did not differ ($P > .10$) and averaged 42.4 mM. Reducing Pi concentration to 2.0 mg/l significantly reduced total volatile fatty acids; acetate and methane production also decreased by 8 % and 35 %, respectively. In experiment 2 ($n=2$), different sources of dicalcium and rock phosphate were evaluated for ruminal availability. Four fermentors were inoculated simultaneously, one received 9.4 mg of Pi (+ control; sodium phosphate) and one received 0 mg of Pi (- control). The other two vessels received 9.4 mg of either a dicalcium source or rock phosphate. Production of total volatile fatty acids averaged 57 mmol/d in the (+) and was reduced ($P < .10$) to 44 mmol/d in the (-). Concentration of Pi in cultures receiving the dicalcium sources averaged 7 mg/l compared with 1 mg/l for cultures receiving rock phosphate. Total volatile fatty acid production for all dicalcium Pi sources was similar ($P > .10$) to the (+) and averaged 61 mmol/d. However, addition of rock phosphate as the Pi source reduced volatile fatty acid production to 36 mmol/d. This was also true for acetate production that was higher for all dicalcium sources compared to rock phosphate. Our data indicate that 6 mg/l of soluble Pi concentration in ruminal cultures supported normal rumen fermentation. Rock phosphate had low phosphorus solubility and resulted in decreased ruminal fermentation compared with dicalcium phosphate.

Key Words: Phosphorus, Rumen microbes, Continuous cultures

326 Effects of natural plant extracts on nitrogen metabolism and fermentation profile in continuous culture. P. W. Cardozo, S. Calsamiglia*, and A. Ferret, *Universidad Autonoma de Barcelona, Spain*.

Eight 1.3-L dual flow continuous culture fermenters were used in two periods (10 d) to study the effects of natural plant extracts on N metabolism and fermentation profile. Fermenters were fed 95 g/d of a 60 to 40 forage to concentrate diet. Treatments (1.5 mg/d per fermenter) were: no extract (C), MX (a mix of all extracts), cassia (CA), garlic (G), anise (A), yucca (Y), marjoram (M) and capsicum (CA). Fermenters were maintained at constant temperature (39°C), pH (6.4) and solid (5%/h) and liquid (10%/h) dilution rates. Each day, a sample was taken 2 h after the morning feeding for the determination of ammonia (NH₃ N) and volatile fatty acids (VFA). During the last 2 days, samples were taken at 0, 2, 4, 6, and 8 h after feeding, and analyzed for peptide (Pep), aminoacid (AA) and NH₃ N concentrations. Data were analyzed using the PROC MIXED (SAS, 1996) and significance declared at $P < 0.05$. Total VFA was similar across treatments (111.3 mM). Acetate concentration (mol/100mol) in A (57.8), M (56.6) and CA (57.4) were higher than C (53.4), and MX (52.4). Propionate concentration (mol/100mol) was lower in Y (26.3), A (25.3), M (25.6) and CA (25.0) versus C (28.4) and MX (28.4). Concentration of NH₃-N (mg/100ml) in A (10.8) was higher versus C (7.9). The Pep-N concentration in hour 2 (mg/100ml) was highest for MX (8.9), CA (8.8), G (10.1) and Y (10.4), and lowest for C (3.3). The AA-N concentration in hour 2 (mg/100ml) was highest in C (12.4), and lowest in G (8.0) and CA (7.7). The NH₃-N concentration in hour 2 (mg/100ml) was highest in A (10.0) and lowest in CA (6.3), G (5.6) and Y (6.0). The effect of individual extracts did not match the action of the MX. The accumulation on Pep-N in MX, CA, G, and Y suggested that peptidolysis was inhibited. The accumulation of AA-N, and the decrease in NH₃-N in G suggested that

deamination was inhibited. Careful selection of these additives may allow to manipulate rate of protein degradation. Acknowledgment: Plant extract and financial support provided by Axiss France SAS.

Key Words: Microbial fermentation, plant extract

327 Comparison between Holstein and Jersey Cows in post-prandial Rumen pH and VFA Concentrations. C.W. Cruywagen*, N. Strickland, and S.J. Schoeman, *University of Stellenbosch*.

The authors have previously reported that Jersey cows on high concentrate diets appeared to be more efficient than Holsteins to digest fibre in the rumen. The reasons for breed differences were not apparent. A study was done under the same conditions to compare post-prandial rumen pH values and volatile fatty acid concentrations in an attempt to explain previously observed differences between breeds. Eight ruminally cannulated cows (4 Holsteins and 4 Jerseys) were used in the trial. All the cows were non-lactating but received a lactating cow TMR from two weeks before, until the end of the trial. The TMR was fed at 08h00 daily (12 kg for Holsteins and 10 kg for Jerseys) and supplementary wheat straw was available *ad libitum*. Samples of rumen liquor were taken at 08h00, 12h00, 16h00, 18h00 and 20h00 on the first day of the trial, representing 0, 4, 8, 10 and 12 hours post-feeding. Initial pH (0h) did not differ between breeds and was 7.48 for Holsteins and 7.72 for Jerseys. A sharp decline in post-prandial rumen pH was observed for Holsteins and pH reached a minimum of 6.08 at 4h post-feeding, which was significantly lower ($P < .01$) than the 6.62 observed for Jerseys at the same time. Values at 8h, 10h and 12h post-feeding did not differ between breeds ($P > .05$) and were 6.18 and 6.2, 6.25 and 6.31 and 6.40 and 6.43 for Holsteins and Jerseys, respectively. Post-prandial molar proportions of acetic acid and propionic acid did not differ between breeds ($P > .05$), but total VFA concentration was higher at 4h ($P < .01$) and 8h ($P < .05$) post-feeding for Holsteins than for Jerseys. Higher total VFA concentrations for Holsteins at 4h post-feeding corresponded with lower pH values. It was observed that the Holsteins ate at a faster rate than the Jerseys and always finished their TMR long before the Jerseys. This could explain the differences observed between the breeds in post-prandial pH profiles. Fibre fermentation in the rumen is suppressed at low pH levels and it was concluded that the lower fibre digestibility values observed earlier for Holsteins could be due to lower pH values observed for at least 6h of the day which was probably caused by a difference in feeding behaviour.

Key Words: Dairy Cows, Rumen pH, Rumen VFA

328 Meta analysis of the acidogenicity of ingredients. S. Giger-Reverdin and D. Sauvant, *UMR INRA - INAPG Physiologie de la Nutrition et Alimentation*.

Several studies stressed the large variations in the ability of ingredients to depress rumen pH *in vitro*. The aim of this work was to study the consistency of the ranking of acidogenicity of ingredients between experiments. A meta analysis was performed on a base including data of four already published papers and our own data. All the ingredients studied by at least two authors were retained. Methods differed between teams: the ratio (volume of incubation/sample mass) varied from 10 to 150 ml/g, the percentage of artificial saliva was comprised between 50 and 80. For the 14 most studied ingredients, the ranking was established on adjusted means of pH (lsmeans) which was accompanied for each feed by its standard error. It was the following one from the more acidogenic to the less one: Cassava (5.70, 0.10), Barley (5.77, 0.06), Citrus pulp (5.82, 0.07), Wheat (5.84, 0.06), Corn gluten feed (5.86, 0.07), Oats (5.87, 0.08), Wheat bran (5.87, 0.08), Beet pulp (5.89, 0.06), Rapeseed meal (5.95, 0.08), Coconut meal (5.98, 0.08), Soybean hulls (6.00, 0.07), Soybean meal (6.01, 0.07), Corn (6.04, 0.06), Sorghum (6.10, 0.06). As stressed by the precision of the model, the hierarchy between feeds hardly differ between teams and was conserved through incubation duration. Thus, these values could be included into feed formulation to take into account the potential acidogenicity of compound feeds formulated with these ingredients.

Key Words: Acidogenicity, Formulation, Ingredients

329 Rates of production of the major rumen volatile fatty acids in lactating cows given normal and milk fat depressing diets. J.D. Sutton*^{1,3}, M.S. Dhanoa², S.V. Morant³, D.J. Napper³, and E. Schuller³. ¹University of Reading, UK, ²IGER, Aberystwyth, UK, ³formerly NIRD, Shinfield, UK.

To examine the relation of the production rates of the 3 major rumen VFA to milk fat depression, 5 rumen-fistulated Friesian cows in mid-lactation were given two contrasting diets supplying similar digestible energy (DE) intakes. Cows were fed, in a 2-period cross-over design, a Normal diet of 9.0 kg concentrate (82% rolled barley (RB), 16% soyabean meal (SBM)) and 6.0 kg long hay (total 12.9 kg DM and 161 MJ DE/d) and a low-roughage diet (LR) of 12.9 kg concentrate (87% RB, 11% SBM) and 1.4 kg long hay (total 12.7 kg DM and 171 MJ DE/d) in two equal portions at 12-h intervals. Rates of VFA production were measured by 22-h intra-ruminal infusions of 0.5 mCi 1-¹⁴C-acetic acid (A), 2-¹⁴C-propionic acid (P) or 1-¹⁴C-n-butyric acid (B) at 4-6 d intervals with sampling over the last 12 h. Results were calculated using a 3-pool, non-steady state model. Rumen fluid volume changes were included in the model and were measured by a 2-marker system and also by rumen emptying but were found to have little influence on calculations of VFA production. On Normal and LR respectively, milk yield was unaffected at 17.8 and 19.6 kg/d but fat content was severely depressed by LR at 34.5 and 22.0 g/kg ($P < 0.001$). Net production rates (mol/d) on Normal and LR were 56.8 and 48.3 for A ($P < 0.10$), 16.3 and 36.4 for P ($P < 0.01$), and 6.5 and 4.7 for B ($P > 0.10$). Molar proportions (%) of net VFA production were 71.3 and 54.2 for A ($P < 0.001$), 20.8 and 40.5 for P ($P < 0.001$) and 7.8 and 5.4 for B ($P > 0.10$) and were broadly similar to molar proportions of rumen concentrations at 68.1 and 51.5 for A ($P < 0.001$), 19.2 and 39.2 for P ($P < 0.001$) and 12.7 and 9.3 for B ($P < 0.01$). Net production of these 3 VFA provided 89 and 108 MJ/d, equivalent to 55 and 63% of DE. The milk fat depression was associated with a small reduction in acetic acid production, doubling of propionic acid production, and a small but non-significant reduction in n-butyric acid production.

Key Words: Rumen VFA Production, Milk Fat Depression, Dairy Cows

330 Gas and VFA production during the *in vitro* fermentation of selected organic acids and sugars. D.O. Molina*, A.N. Pell, and P. Schofield, *Cornell University, Ithaca, New York*.

The study aimed to examine gas and VFA production and microbial yield from fermentation of selected organic acids (OA) and sugars. Citric, malic and lactic acids were included in *in vitro* medium at three concentrations, 10, 25 and 40 mM. The experiment was repeated twice: in the first experiment, ruminal fluid was filtered through four layers of cheesecloth and one layer of glass wool. In the second experiment, the ruminal fluid was centrifuged and the resulting pellet was resuspended in fresh medium prior to inoculation. In a third experiment, the same OA and two sugars, glucose and arabinose, were included in the standard *in vitro* medium (40 mM), using an inoculum of centrifuged ruminal fluid. In all cases, fermentations were conducted with the appropriate OA or sugar as the substrate either with or without 25 mg of soy hulls. Differences in fermentation among the OA are clear. Citric acid produced the highest gas volumes but did not always have the highest rate of gas production. It also produced the highest acetate and lowest propionate concentrations. More purines were detected in the lactic acid fermentations although the dry weights of the pellets from the lactic acid were not higher than that of the other acids. Fermentation of sugars resulted in more gas production than OA but the rate of gas production from arabinose was similar to that from lactic acid. It is concluded that significant differences ($P < 0.05$) in fermentation exist among various OA and between OA and sugars.

Acid	Citric	Malic	Lactic	Citric	Malic	Lactic	SE
Variable	No Soy hulls			Soy hulls			
Rate/h	0.11 ^a	0.07 ^b	0.12 ^a	0.08 ^a	0.05 ^b	0.05 ^b	0.01
Vfinal, mL	10.2 ^a	5.9 ^b	7.4 ^c	15.3 ^a	12.3 ^b	12.9 ^c	0.2
Acetic, mM	48.6 ^a	8.9 ^b	5.4 ^c	62.1 ^a	18.2 ^b	12.1 ^c	1.3
Propionic, mM	2.3 ^a	6.7 ^b	7.0 ^b	4.5 ^a	12.4 ^b	9.5 ^c	0.3
Pellet, mg	7.7 ^a	8.3 ^a	9.6 ^a	28.9 ^a	23.2 ^b	23.3 ^b	0.7
Purines, µg	45.1 ^a	49.0 ^a	82.7 ^b	137.1 ^a	136.7 ^a	163.4 ^b	3.3

Substrate	Arabi-					
	Glucose	nose	Citric	Malic	Lactic	SE
Variable	No Soy hulls					
Vfinal, mL	19.8 ^a	20.1 ^a	13.3 ^b	6.6 ^c	7.7 ^d	0.2
Rate/h	0.69 ^a	0.17 ^b	0.12 ^c	0.07 ^d	0.20 ^b	0.01
Soy hulls						
Vfinal, mL	28.2 ^a	25.6 ^b	17.6 ^c	12.8 ^d	13.5 ^e	0.2
Rate/h	0.47 ^a	0.10 ^b	0.16 ^c	0.05 ^d	0.09 ^b	0.01

Key Words: Organic acids, Sugars, *In vitro* fermentation

331 Interaction between FermentenTM or soybean meal and fermentability of carbohydrate source on microbial yield and efficiency in continuous culture. W.H. Hoover^{*1}, T.M. Miller¹, J.E. Nocek², and W.E. Julien², ¹West Virginia University, ²Bioavance Technologies Inc..

A continuous culture study was conducted to evaluate the effect of protein and carbohydrate sources on rumen microbial yield and efficiency. Within the dual flow continuous culture system, liquid and solids dilution rates were 0.13 hr⁻¹ and 0.05 hr⁻¹ respectively. Culture pH was not controlled and feeding frequency was 2x/d. The design was a 2 x 2 factorial with protein and carbohydrate as the main effects. There were three replications with eight d fermentations per replication. The forage:concentrate ratio of the basal diet was 56:44. Treatments were: 1) ground corn and SBM, GC-SBM; 2) ground corn and FermentenTM (Bioavance Technologies Inc. Omaha, NE), GC-F; 3) steam-flaked corn-barley and SBM, SF-SBM; and 4) steam-flaked corn-barley and FermentenTM, SF-F. Microbial growth (g N/d) and efficiency (g microbial N/kg OM fermented) were 2.36 and 45.4, 2.28 and 43.8, 2.51 and 48.6, 2.78 and 51.6 for GC-SBM, GC-F, SF-SBM and SF-F respectively. Substituting steam flaked corn-barley for ground corn resulted in increased microbial growth and efficiency (P<0.02). There was a carbohydrate x protein interaction for microbial growth (P<0.05) and efficiency (P<0.15) whereby the combination of steam flaked corn-barley and FermentenTM increased microbial N production by 11% compared to steam flaked corn-barley/SBM and 17 and 22% more than ground corn with either SBM or FermentenTM respectively. These data suggest that the combination of steam flaked corn-barley and FermentenTM acted synergistically in enhancing microbial protein yield and efficiency compared to any other combinations tested.

Key Words: microbial protein synthesis, rumen

332 Selection of *Propionibacterium* strains capable of utilizing lactic acid from *in vitro* models. T.D. Parrott^{*1}, T.G. Rehberger¹, and F.N. Owens², ¹Agtech Products, Inc., Waukesha, WI, ²Oklahoma State University, Stillwater, OK.

Forty-four strains representing four species of *Propionibacterium* were screened for lactic acid utilization to examine their potential for use in a direct-fed microbial to prevent lactic acidosis in cattle consuming large amounts of highly fermentable carbohydrate. Strains were tested for utilization of lactic acid and growth in a nutrient broth supplemented with 80 mM lactic acid at two different pH values - one representing the pH of an acidic rumen (5.0) and the other that of a forage-fed ruminant (7.0). No differences (p>.05) in growth and lactic acid utilization were detected among strains at pH 7.0. Data from pH 5.0 experiments showed *P. freudenreichii* strains P49 and P99 utilized 76.90 mM and 78.59 mM of lactic acid respectively, which was significantly (p<.05) more compared to other strains. Compared with strains of *P. acidipropionici*, *P. jensenii* and *P. thoenii*, *P. freudenreichii* strains reached higher cell densities and utilized more lactic acid at pH 5.0. Rumen fluid simulation models were used to examine the ability of fifteen selected propionibacteria strains to survive and utilize lactic acid produced by native ruminal

microorganisms. Eleven of the fifteen propionibacteria strains tested utilized lactic acid in the rumen model. Compared with other strains, P42 had the highest rate of pH increase (.0377 units/h), but was not different (p>.05) from strains P63, P54, P25, and P41. Strain P42 also had the highest rate of lactic acid utilization (1.61 mM/h) compared to others, but was not different (p>.05) from strains P63, P54, P25, P41, P111, P81, and P104. Gompertz non-linear curve fitting equation revealed that strains P54 and P63 increased (p<.001 and p<.01 respectively) the lag time for lactic acid accumulation and suppressed the rate of H+ concentration. These results suggest that *Propionibacterium* may be able to utilize ruminal lactic acid, thus preventing ruminal pH decline in cattle consuming high concentrate rations.

Key Words: *Propionibacterium*, Rumen, Lactic acid utilization

333 Quantitative analysis of *in situ* starch degradation in the rumen. A. Offner^{*1}, D. Sauvant¹, P. Chapoutot¹, J. Van Eys², and A. Bach², ¹INRA - INA PG, Paris, ²Agribands International, St. Louis.

The objective of this study was to predict ruminal starch degradation for various feedstuffs. The equation ED = a + b x c / (c + k) was generally used to calculate starch effective degradability. The parameters a, b and c represent the rapidly degradable fraction, the potentially degradable fraction and the degradation rate of fraction b, respectively. The passage rate (k) was considered to be equal to 6%/h. A database on starch degradation including the parameters (a, b, c) and also the kinetic values was built from 47 references (291 observations). Data were analyzed using the GLM procedure. The model took the effects of laboratory (lab) and raw materials (rm) into account, these two factors being significant (P < 0.001). This model predicted the effective degradability with an R² of 82% (rsd=7.9, sd_{lab}=16.2 and sd_{rm}=32.5). A similar model predicted starch "a" fraction with an R² of 72% (rsd=16.0, sd_{lab}=40.2 and sd_{rm}=41.6). The least squares means were collected and results with at least 3 observations are presented. This approach can be used to predict ED with standard deviations ranging from 1.8 to 4.9%.

Ingredients	a, %starch*	Starch ED, %*
Corn	22.1 (27, 3.7)	60.2 (28, 1.8)
Ground Corn	32.5 (6, 7.5)	71.6 (5, 4.1)
Extruded Corn	39.4 (3, 10.3)	77.5 (4, 4.4)
Pelleted Corn	21.0 (3, 9.9)	64.9 (3, 4.9)
Corn Gluten Feed	53.3 (6, 7.4)	86.5 (6, 3.7)
Corn Silage	54.0 (14, 5.4)	83.8 (14, 2.7)
Sorghum	25.4 (8, 6.3)	59.5 (9, 3.0)
Barley	46.1 (25, 3.9)	88.7 (26, 1.9)
Ground Barley	62.9 (3, 11.6)	99.8 (3, 5.7)
Wheat	66.2 (12, 5.5)	95.1 (12, 2.7)
Wheat by-products	78.5 (9, 6.2)	98.2 (9, 3.0)
Oats	73.7 (5, 7.7)	97.4 (5, 3.8)
Ricebran	12.7 (5, 8.0)	74.3 (5, 3.9)
Potato	47.3 (7, 6.7)	79.4 (7, 3.3)
Faba beans	42.1 (5, 8.2)	77.6 (5, 4.0)
Toasted Faba beans	35.7 (11, 6.2)	65.7 (11, 3.1)
Peas	41.0 (8, 6.6)	79.3 (8, 3.3)
Toasted Peas	26.6 (10, 6.4)	61.6 (10, 3.2)

*Mean (number of observations, standard deviation)

Key Words: Starch, Degradation, In situ kinetics

334 Influence of post-ruminal partially hydrolyzed starch and casein on pancreatic α-amylase expression in calves. K. C. Swanson^{*}, J. C. Matthews, C. A. Woods, and D. L. Harmon, University of Kentucky, Lexington.

The objective of this experiment was to examine the effects of post-ruminal partially hydrolyzed starch (SH) and/or casein on the expression of pancreatic α-amylase mRNA, protein, and enzyme activity in calves. Twenty-four Holstein calves (88 ± 3 kg), fitted with abomasal infusion cannulas, were randomly assigned within block (wk of infusion) to one of four abomasal infusion treatments. Calves were fed an alfalfa-based diet to supply 1.2 x NEm requirement and to exceed requirements for ruminally degradable intake and metabolizable protein for a steer gaining 0.33 kg/d. Abomasal infusion treatments (3000 mL total volume infused/d) were control (water), SH [4 g/(kg BWd)], casein [0.6 g/(kg BWd)], and SH+casein. Treatments were infused abomasally for 10 d

before tissue collection. Casein infusion increased pancreatic weight by 74% and α -amylase mRNA expression by 69% in the absence of SH, but did not influence pancreatic weight and α -amylase mRNA expression in the presence of SH (SH \times casein, $P < 0.10$). Infusion of SH decreased ($P = 0.02$) pancreatic α -amylase protein expression by 67% and activity (U/g pancreas) by 63%. Casein infusion did not influence pancreatic α -amylase protein expression and activity (U/g pancreas). Casein infusion increased total α -amylase activity (kU/pancreas) by 148% in the absence of SH, but did not influence total α -amylase activity (kU/pancreas) in the presence of SH (SH \times casein, $P = 0.05$). These data suggest that increases in small intestinal SH decrease pancreatic α -amylase expression largely by post-transcriptional events. Increases in small intestinal protein increase pancreatic weight and total α -amylase activity, whereas small intestinal SH inhibits these increases.

Key Words: calves, α -amylase, post-ruminal nutrients

335 Abomasal infusion of casein enhances abundance and activity of Na⁺/glucose cotransporter along the small intestine of lambs. S. J. Mabweesh*, D. Guy, and D. Sklan, *The Hebrew University.*

The purpose of this study was to determine the effect of abomasal casein infusion on glucose uptake and abundance and activity of the Na⁺/glucose cotransporter (SGLT1) in brush border membrane vesicles (BBMV) prepared from mucosa in different regions of ovine small

intestine. Lambs (body weight 35 ± 1.0 kg) were surgically fitted with abomasal infusion catheters and were fed diets containing equal portions of wheat hay and cracked corn. Lambs were infused with either 500 g/d water or with 500 g/d water containing 35 g casein. The infusion period lasted 10 d, after which lambs were slaughtered, exsanguinated, and eviscerated. Intake and total tract digestibility of nutrients were similar between treatments and averaged 1134, 1142 and 486 g/d, and 67, 70, 94% for dry matter, organic matter, and non-structural carbohydrates. Crude protein digestibility was higher by 15% in the casein-infused lambs. Glucose uptake to BBMV ranged from 101 to 337 pmol.mg protein⁻¹.sec⁻¹ along the small intestine and was highest in the mid section of the small intestine. In the mid jejunum glucose uptake was higher ($P < 0.07$) in lambs infused with casein and averaged 120 compared to 68 pmol.mg protein⁻¹.sec⁻¹ in the control group. SGLT1 affinity was similar in the different segments of the small intestine of lambs infused with casein and averaged 106 mM. In contrast in the control group a scattered range of values was found in the control group with lowest values in the duodenum. SGLT1 protein abundance correlated positively with glucose uptake in the BBMV in the casein treated lambs, but not in the control group. These data suggest that glucose uptake along the small intestine of lambs is directly influenced by casein or its derivatives in the small intestine via SGLT1 affinity at the brush border membrane. SGLT1 activity may be regulated by post-translational events affected by amino acids and peptides.

Key Words: Sheep, Starch digestion, Glucose transporter (SGLT1)

ASAS/ADSA Ruminant Nutrition: Transition Cow

336 An overview of dietary factors influencing dry matter intake and milk protein yield in early lactation dairy cows. A. N. Hristov*¹, W. J. Price², and B. Shafiq², ¹Department of Animal and Veterinary Sci., ²Statistical Programs, College of Agriculture, University of Idaho, Moscow, ID 83844.

The objective of this meta-analysis was to determine the factors mostly responsible for the variation in DMI and milk protein yield (MPY) in lactating dairy cows. Diets (467) from feeding trials conducted in the U.S. and Canada involving Holstein cows less than 100 DIM published in *J. Dairy Sci.* (volumes 73 through 82) were analyzed for nutrient composition (CPMDairy program). The average DMI of the cows involved in this study was 22.1 kg/d (varying from 16.0 to 29.9 kg) and the average milk yield was 33.0 kg/d (varying from 20.1 to 46.0 kg). The relationships between DMI and MPY with variables representing the chemical composition of the diet and ruminal fermentability of carbohydrate (CHO) and nitrogen fractions were investigated. Principle component analysis (PCA) was used to reduce the dimension of the underlying data and identify specific sources of variability. More than 80% of the data variability was accounted for by the first three components representing starch, fiber and protein intakes. Dominant variables contributing to these axes were non-structural CHO, CHO fraction B1 and fermentable CHO fraction B1 for starch, NDF, CHO fractions B2+C and fermentable CHO fractions B2+C for fiber, and soluble and degradable protein intakes for protein. A subsequent regression analysis was carried out to investigate the relationships between these dietary attributes and the response variables DMI and MPY. A three-parameter model involving CHO fraction B1, NDF, and soluble protein intakes was deemed appropriate for DMI, accounting for 91% of the response variability. Whereas, CHO fraction B1, degradable protein, and NDF intakes were the best explanatory variables for MPY, accounting for 41% of the response variability. In conclusion, during the first 100 days of lactation, starch and NDF intakes were the most important variables in determining DMI, while starch intake was the important variable in determining MPY.

Key Words: Dairy Cows, Dry Matter Intake, Milk Protein Yield

337 Dry period protein nutrition and glucose and protein metabolism in transition cows. W.S. Burhans*¹, R.M. Slepatis¹, P.J. Reeds², and A.W. Bell¹, ¹Cornell University, Ithaca, NY, ²USDA-ARS CNRC, Houston, TX.

The effect of protein nutrition during the dry period on periparturient glucose flux and protein metabolism was assessed in multiparous Holstein cows. Cows (n=12) were dried off at -67 days from expected calving date and fed a common diet (HIGH) containing 157g/kg CP,

40.9% NDF, 34.8% NFC, and 1.59 Mcal/kg NEI. At -60 d and -20 d before expected calving and +3 d after calving cows were infused with a complete mix of ¹⁵N labeled amino acids (AA) and [6-²H] glucose for 8 h (AA) and 4 h (glucose) respectively. Hourly blood samples were taken to determine plasma isotopic enrichment. After infusion for 8h a liver biopsy was taken for determination of protein fractional synthesis rate (FSR) from hepatic incorporation of ¹⁵N AA. After the infusion 6 cows were assigned to a diet (LOW) containing 7.9 g/kg crude protein, 40.9% NDF, 46.2% NFC, and 1.56 Mcal/kg. Cows remained on HIGH or LOW diets until calving, when a common lactating diet was fed containing 175 g/kg CP, 31.1% NDF, 38.9% NFC, and 1.74 Mcal/kg. Tabulated results suggest minimal effects of dry period dietary protein concentration on periparturient glucose or AA metabolism. High dry period DMI and inclusion of additional corn starch to the LOW diet may have ameliorated potential negative effects of low dietary protein concentration. Increased glucose flux postcalving is consistent with increased glucose demand immediately postpartum. Additional work is needed to assess the significance of low dry period protein concentration when intake is low or restricted or when periods are less glucogenic.

	Far Dry		Close Dry		Lactation		SEM	Prot	P	PxT
	Cov.	H	L	H	L					
Body weight, kg	692	754	711	660	613	18	NS	<.001	NS	
DMI Intake, kg	12.7	11.0	11.8	13.0	10.0	0.7	NS	NS	NS	
Glucose Kd, g/kg.d	3.62	3.53	2.97	3.91	4.32	0.18	NS	<.05	NS	
Glucose Kd, g/d	2472	2651	2081	2536	2637	97	NS	NS	NS	
Prot Kd, g/kg.d	5.11	5.13	5.07	5.76	6.25	0.38	NS	NS	<.1	
Prot Kd, g/d	3485	3813	3600	3752	3758	239	NS	NS	NS	
Liver FSR	0.172	0.184	0.172	0.238	0.314	0.027	NS	<.1	NS	
N bal. d2-d7				- 49	- 63	17	NS			

Key Words: Transition cow, metabolism

338 Production responses of dairy cows to dietary supplementation with conjugated linoleic acid (CLA) during the transition period and early lactation. G. Bernal-Santos*, J. W. Perfield II, T. R. Overton, and D. E. Bauman, *Cornell University, Ithaca NY*.

Thirty Holstein cows entering second or later lactation were utilized to determine whether feeding rumen-protected CLA from 21 d prepartum through 56 d (8 weeks) postpartum would affect dry matter intake (DMI), milk production, or milk composition. Cows were fed common diets as TMR both before and after parturition, and diets were top-dressed with either 116 g/d of a commercial rumen-protected fat supplement (EnerGII; Bioproducts Inc., Fairlawn, OH) as a control or 126 g/d of a rumen-protected CLA supplement (Agribands Purina Canada, Inc., Woodstock, ON). Treatment amounts were calculated to provide the same total amount of fatty acids. The CLA supplement provided 42.8 g/d of CLA. Predominant CLA isomers (wt. %) were: trans-8 cis-10 (9.2%), cis-9 trans-11 (25.1%), trans-10 cis-12 (28.9%), and cis-11 trans-13 (16.1%). Differences in prepartum (12.1 vs. 13.1 kg/d) and postpartum (20.5 vs. 21.6 kg/d) DMI for control and CLA treatments were not significant ($P > 0.20$). Feeding CLA during the transition period and early lactation tended ($P < 0.14$) to increase overall milk yield (42.6 vs. 45.2 kg/d), and a trend ($P < 0.07$) occurred for an interaction of treatment and week because differences increased as week of lactation increased. Feeding CLA decreased ($P < 0.01$) milk fat percentage (3.87 vs. 3.46%). As a result of these offsetting changes in milk yield and milk fat percentage, differences in yields of fat (1.62 vs. 1.52 kg/d) and 3.5% fat-corrected milk (44.9 vs. 44.2 kg/d) were not significant ($P > 0.20$). Differences in the percentage (2.87 vs. 2.89%) and yield (1.20 vs. 1.27 kg/d) of true protein in milk, and the concentration milk urea nitrogen (12.8 vs. 12.7 mg/dl), were not significant ($P > 0.20$). Results suggest that feeding CLA to dairy cows during the transition period and early lactation causes a moderate decrease in milk fat content, tends to increase milk yield, and does not affect DMI.

Key Words: transition period, conjugated linoleic acid, milk fat

339 Changes in Rumen Capacity during the Periparturient Period in Dairy Cows. A.F. Park*, J.E. Shirley, J.M. DeFrain, E.C. Titgemeyer, E.E. Ferdinand, R.C. Cochran, D.G. Schmidt, S.E. Ives, and T.G. Nagaraja, *Kansas State University, Manhattan*.

Four ruminally fistulated, multiparous, pregnant Holstein cows were utilized in a randomized design to delineate ruminal adaptations as the cow transitions from gestation into lactation. Ruminal measurements were obtained 72 (late lactation), 51 (far-off dry), 23, and 9 d (close-up dry) prepartum and 6, 20, and 34 d postpartum. Net energy of lactation (Mcal/kg) and crude protein percentage of the diets were 1.57, 15.6; 1.55, 10.9; 1.57, 15.0; 1.61, 17.0 for late lactation, far-off dry, close-up dry, and early lactation, respectively. On each sampling day, rumens were evacuated prior to feeding; contents were weighed and sampled to determine fill, and then the rumen was filled with water with the cannula cap intact to prevent water from exiting via the cannula. Ruminal water holding capacity (RWC) was determined as the amount of water subsequently removed from the rumen. Dry matter intake expressed as a percent of body weight (quadratic, $P < 0.001$) declined as stage of gestation advanced but increased following parturition. Body weight and condition were highest just prior to parturition (quadratic, $P < 0.001$). RWC gradually increased from the far-off period into early lactation (linear, $P < 0.01$). Total and liquid fill were lowest during the close-up dry period (quadratic response, $P < 0.01$). Dry matter fill (quadratic response, $P < 0.001$) and dry matter fill as a percentage of RWC (quadratic response, $P < 0.01$) were lowest during the early close-up dry period. Total fill as a percentage of RWC was highest during the far-off period (quartic response; $P < 0.05$). Liquid fill as a percentage of RWC was highest during the far-off dry period and decreased as cows approached parturition (quartic response, $P < 0.05$). These data demonstrate that physical capacity of the rumen is not the causative factor of prepartum intake depression.

Key Words: Rumen capacity, Periparturient, Dairy

340 Effects of Fermentable Carbohydrate Sources on Dry Matter Intake, Milk Production, and Blood Metabolites of Transition Dairy Cows. R.S. Ordway*, V.A. Ishler, and G.A. Varga, *The Pennsylvania State University, University Park, PA*.

Thirty-four multiparous Holstein cows (780 17.2 kg BW; 3.39 0.08 BCS) were used in a completely randomized design to evaluate the effects of fermentable carbohydrate sources on dry matter intake, milk production, and blood metabolites of transition cows. Treatments were initiated 30 d prior to expected calving date and continued through calving. After parturition, animals received 50% of their respective prepartum diets and 50% of a typical lactating cow TMR until intake reached 14.5 kg DM at which time they received only the lactating cow ration until 56 d postpartum. The prepartum diet was formulated to contain 1.5 Mcal/kg NEL, 41.3% NDF, and 14.8% CP. The control diet (% DM) consisted of 42% corn silage, 10.6% SBM, 5.5% corn cobs, 10.9% cottonseed hulls, 6.4% soyhulls, 4.3% liquid molasses, 3.8% alfalfa dehydrate, 4.9% vitamin and mineral mix, 0.4% urea, 0.5% Pro Base, and 10.3% ground corn. The treatment diet consisted of replacing 2.4% of the corn with sucrose on a DM basis. Significance was declared at $P \leq .10$ using the MIXED procedure of SAS[®]. Prepartum glucose levels were higher (66.3 ± 1.2 vs. 69.3 ± 1.1 mg/dl) ($P < .08$) for cows fed the diet containing sucrose but were not different postpartum. Neither prepartum or postpartum NEFA, BUN, or insulin differed between treatments. DMI averaged 16.3 ± 0.61 kg/d for the last 4 weeks prepartum and 21.9 ± 0.76 kg/d for the first 8 wk postpartum. Milk yield averaged 45.7 ± 1.6 kg/d, fat averaged $3.7 \pm 0.09\%$ and protein averaged $2.7 \pm 0.05\%$ for the first 8 wk postpartum and were not different among treatments. Prepartum DMI in the current study was 20% higher compared to our last 2 trials in which diets were formulated to contain approximately a 70:30 forage to concentrate ratio. Based on our current study, replacing ground corn with sucrose did not enhance prepartum or postpartum intake or performance.

Key Words: Fermentable Carbohydrate, Nonforage Fiber, Transition Cow

341 Effect of liquid flavor supplementation on performance of dairy cows in the transition period. M. A. Shah*, E. J. Friedman, B. A. Fadl-alla, and M. R. Murphy, *University of Illinois at Urbana-Champaign*.

A nine-week trial was conducted to study the performance of twenty-four Holstein cows during the transition period (3-wk prepartum and 4-wk postpartum). Cows were assigned to either a control or liquid-flavored (0.52 ml/kg of feed) TMR in a randomized complete block design. The TMR contained corn silage, alfalfa haylage, cottonseed and a grain mix based on ground corn and soybean meal. Cows were fed to ensure 10%orts and the diet provided (on a DM basis) 13% CP, 32% ADF, 44% NDF and 1.54 Mcal/kg prepartum and 17.5% CP, 30% ADF, 40% NDF and 1.54 Mcal/kg postpartum. An additional 2.3kg of alfalfa hay was fed the first 5 d postpartum. Weekly means of DMI, milk yield, milk protein, milk fat, SNF, SCC and BW were analyzed using a repeated measures procedure. There was no effect of treatment on these variables ($P > 0.10$), and least-squares means were 16.9 and 15.7 kg/d, 38 and 35.3 kg/d, 3.10 and 3.11%, 3.69 and 3.74%, 8.37 and 8.16%, 1.99×10^5 and 4.33×10^5 , and 631 and 651 kg for cows on control and flavored diets, respectively. Individual cow postpartum DMI data were fitted with an exponential model $[DMI = a + b * e^{(-c * DIM)}]$, where DMI in kg, 'a' asymptotic DMI, 'b' potential for increase in DMI, 'c' rate of increase in DMI]. Rates of increase in DMI were similar, 0.139 and 0.123 for control and flavored diets, respectively. Data for both groups were separately analyzed using multiple regression with FCM as the dependent variable, and BW and DMI as independent variables. More BW was mobilized per unit increase in FCM in cows fed the control than in cows fed the flavor diet. Cows fed control diet were in more negative energy balance during early lactation (especially during wk 1 and 2 postpartum) than cows fed flavored diets ($P < 0.10$). It was concluded that, feeding flavor improved energy balance of cows in early lactation and may reduce the risk of health or reproductive problems.

Key Words: feed flavor, early lactation, prediction model

342 Effects of day relative to parturition and dietary crude protein levels on rumen fermentation in pre-fresh transition cows. M. E. Dorshorst*, S. J. Bertics, and R. R. Grummer, *University of Wisconsin, Madison.*

Eight nulliparous and 12 first parity or greater Holstein cows were used in a randomized block design to examine changes in rumen fermentation as cows fed 10 or 12% CP diets approach parturition. Cows were blocked according to expected calving date and parity. Diets were isocaloric (1.56 Mcal/kg DM) and the difference in CP was achieved by the addition of urea. Diets were fed as a TMR for ad libitum intake. All cows were fed the 10% CP diet starting at d -35 prior to expected parturition. At d -28, one-half of the cows were randomly assigned to the 12% CP diet until parturition. Dry matter intake was measured daily. Rumen fluid samples and estimates of ruminal fiber degradation via in situ dacron bags were obtained at 7 d intervals until d -7 when they were obtained every other day until parturition. There was no effect of treatment or day on rumen pH and total VFA. As cows approached calving, DMI decreased. Rumen NH₃ concentration was significantly increased by feeding the 12% CP diet. Disappearance of NDF after 8 h from dacron bags was affected by day, but not by dietary CP level. Disappearance of NDF after 24 h of incubation tended to be affected by day and was significantly increased by feeding 12% CP. It appears that feeding less than 12% CP to pre-fresh transition cows may limit fiber degradation in the rumen.

Parameter	Day						SEM
	d -21	d -14	d -7	d -5	d -3	d -1	
DMI, kg/d ¹	12.1	11.9	11.5	10.7	10.0	9.0	0.51
NH ₃ , mg/dl ^{A,2}							
10% CP	0.8	2.6	1.4	1.1	1.9	3.4	1.5
12% CP	3.5	3.2	5.0	3.0	3.8	5.1	1.6
8 h NDF ^{B,1}							
10% CP	25.5	25.6	31.8	27.6	27.8	21.8	3.3
12% CP	26.1	26.1	28.6	28.3	27.6	24.8	3.2
24 h NDF ^{B,3,4}							
10% CP	35.5	35.9	37.5	40.2	37.1	33.6	3.2

¹ Day (P < .0001), ² Treatment (P < .05), ³ Treatment (P < .01), ⁴ Day (P < .10), ^A 4 h Post feeding, ^B % Disappearance

Key Words: protein, fiber degradation, transition cows

343 Metabolic measures around parturition for late gestation cows supplemented with moderate and high dietary calcium during hot weather. P. S. Chan*, J. W. West, and J. K. Bernard, *University of Georgia, Tifton, GA/USA.*

Nine multiparous and 12 primiparous Holstein cows were fed diets containing moderate Ca (100g/d) or high Ca (170g/d) for 21d prepartum to determine the effects of dietary Ca fed with diets containing anionic salts. Cows were monitored on day 21 to 1 prepartum (PRE), day 0, 1 and 2 (CALVING) and day 3 to 21 postpartum (POST). Dietary cation-anion difference (DCAD) for prepartum diets was - 6.43 meq/100g DM (Na + K - Cl - S). Cows were fed positive DCAD diets with 0.88% Ca postpartum. The study was conducted from August 10 to November 16 and mean maximum and minimum ambient temperature and relative humidity were 27.3 and 17.4°C, and 91.7 and 50.7% respectively. There was a 28% decrease in DMI the final week prepartum. No treatment effects on DMI were noted. Mean serum Ca for PRE, CALVING and POST were 9.72, 8.43 and 9.40 mg/dl and there were no treatment effects. Mean serum Ca was higher (P<0.06) for primiparous than multiparous cows (9.47 vs 9.19 mg/dl) for the trial. Mean urine Ca (mg/dl) during PRE, CALVING and POST were 43.07, 4.14 and 2.21 (moderate Ca) and 53.70, 6.19 and 2.33 (high Ca) with no treatment effects. Mean HCO₃⁻ (mmol/L) for PRE, CALVING and POST were 20.10, 25.86 and 26.01 (serum) and 0.36, 45.25 and 109.20 (urine). Mean urine pH for PRE, CALVING and POST were 5.66, 7.45 and 8.24. No dietary treatment effects were noted for all HCO₃⁻ and pH measures. The correlation coefficient for urine pH and urine HCO₃⁻ was 0.85 (P<0.0001). Milk yield was 15.9, 23.8 and 26.2 kg/d for 1, 2 and 3wk postpartum, and there was no difference in mean milk yield for moderate and high Ca treatments (22.3 and 20.1 kg/d). Cows maintained adequate serum Ca levels during the periparturient period for both treatments. Primiparous cows had higher serum Ca compared with multiparous cows.

Results suggest 100g/d Ca is adequate to maintain acceptable blood Ca around parturition during warm weather.

Key Words: Hypocalcemia, DCAD, Heat stress

344 Peripartum responses of Holstein cows and heifers fed graded concentrations of calcium (calcium carbonate) and anion (chloride) 3 weeks before calving. D. K. Beede*, T. E. Pilbeam, S. M. Puffenberger, and R. J. Tempelman, *Michigan State University, East Lansing, Michigan, USA.*

Objective was to determine the effects on peripartum metabolic and health responses, and lactation performance of feeding graded concentrations of Ca without or with supplemental chloride for 3 wk before calving. Pregnant animals (n=420) in two research farms were blocked by parity and assigned randomly to one of five dietary treatments (trt). Postpartum parities were: 164 1st; 82 2nd; and, 174 3rd and greater. Prepartum basal diet fed once daily was 18% alfalfa haylage: 42% corn silage: 40% concentrate. A mixture (16.7% of dietary DM) of HCl-treated, heat-extruded soybean meal (HCl-HESBM) and non-HCl-treated-HESBM was used to vary cation-anion difference (CAD; meq[(Na + K) - (Cl + S)]/100 g of dietary DM). Graded amounts of calcium carbonate were used to vary dietary Ca content. For the entire experiment, average analyzed Ca (%) and CAD of each trt were: (A) 0.47, +18; (B) 0.47, -4; (C) 0.98, -4; (D) 1.52, -4; and (E) 1.95, -4. Weekly urine pH measurements were used to adjust proportions of HCl-HESBM and non-HCl-treated-HESBM to maintain pH between 6.0 and 6.7 for B, C, D, and E. Urine pH the week before calving was 8.1 vs. 6.4, 6.6, 6.6, and 6.6 for A vs. B, C, D, and E (P<0.01). Prepartum DMI was greater for A, B, and C than for D and E (P=0.01). Caudal vein blood was collected within 24 h after parturition. Plasma ionized Ca (iCa) was: 4.29 vs. 4.39, 4.43, 4.53, and 4.52 mg/dl for A vs. B, C, D, and E (P=0.02). Plasma Cl was higher for cows fed B, C, D, and E compared with A throughout the prepartum period (P<0.01). Pre- or postpartum body condition and udder edema scores, cow BW, calf birth weight, and colostrum score were not affected by trt. Overall incidence rates (all parturitions) of ketosis (16.7%), retained placenta (12.2%), milk fever (7.7%), hypocalcemia (16.8%), abomasal displacement (10.3%), and mastitis (7.2%) were not affected by trt. Incidences of clinical milk fever and hypocalcemia (plasma iCa <4 mg/dl) were greater in 3rd and greater parity cows in A vs. B, C, D, and E (P<0.03). Average postpartum DMI (19.8 kg/d) and milk yield (35.7 kg/d) through 70 DIM were not affected by trt. Overall, peripartum health and performance responses were optimum when the anion-supplemented diet (CAD = -4 meq/100 g of dietary DM) contained 0.98% Ca when supplemental Ca was from calcium carbonate.

Key Words: Calcium, Anion, Dietary cation-anion difference

345 Subacute Ruminal Acidosis in Dairy Cows, an Experimental Model. S.E. Ives*, T.G. Nagaraja, A.F. Park, and J.E. Shirley, *Kansas State University.*

Five ruminally fistulated lactating Holsteins, 492 days in milk, producing 32.6 kg/d were used to compare ruminal acidosis induced with a challenge diet deficient in effective neutral detergent fiber (eNDF) or with greater starch availability. The experiment was a crossover design with 15 d periods. Cows were fed a basal diet containing (% DM) chopped alfalfa hay (50), ground corn (35), whole cottonseed (11), Soybest (1), molasses (1), and vitamins and minerals (2). The basal diet was fed ad libitum twice daily. On d 8 to 11, cows were fed on a % of BW equal to the lowest intake for the period. Diets were provided at 2.5% of BW for period 1 and 2.8% for period 2. On d 12, ruminal samples were taken prior to feeding and p.m. feeding was skipped. On d 13 to 15, cows were challenged with dietary treatments of AP (alfalfa pellets replaced chopped alfalfa 1:1 DM basis, reduced eNDF) and SFC (steam-flaked corn replaced ground corn 1:1 DM basis, increased starch availability) to induce subacute ruminal acidosis. Cows were offered the entire daily allotment in the a.m. and feed not consumed in 2 h was placed in the rumen via the cannula. Ruminal samples were taken 3, 6, 9, 12, and 24 h relative to feeding each day and analyzed for pH, total volatile fatty acids (TVFA), and lactate. Cows were considered acidotic when ruminal pH was below 5.6 after feeding and maintained until the next feeding. Acidosis was not evident until d 15 and only AP induced acidosis (pH; diet x h, P < 0.01). On d 14, cows receiving AP had ruminal pH below 5.6 from h 6 to 12. By h 3 of d 15, cows challenged with AP had ruminal pH below 5.6 and it remained below 5.6 through the end of the

d. Cows receiving SFC experienced a ruminal pH below 5.6 on h 6 to 12 on d 14 and h 6 to 9 of d 15. Overall, reducing the effective NDF of a lactation diet appeared to provide a model for induction of subacute ruminal acidosis in dairy cows.

Key Words: Acidosis, Dairy Cows

346 The effect of Tasco™ inclusion in the prepartum diet on the proportion among bovine leukocyte populations in blood and mammary gland secretions. T. J. Wistuba*, E. B. Kegley, T. K. Bersi, and G. F. Erf, *University of Arkansas, Fayetteville AR/USA.*

The effects of Tasco™ inclusion in the diet during the last 21 d of gestation on the proportion among bovine leukocyte populations in blood (WBC) and mammary gland secretions (MGS) was investigated using flow cytometric analysis. Thirty Holstein cows were stratified by parity and randomly assigned to the Tasco™ (170 g/d) supplemented group or control diet. Tasco™ is a product derived from *Ascophyllum nodosum*, a brown seaweed that grows along the coast of Nova Scotia. Treatments were initiated 21 d prior to expected parturition and fed until calving. Blood samples from cows and calves, as well as MGS samples were obtained at parturition and at d 1 post partum. In cows, supplementation of Tasco™ increased the proportion of granulocytes (P = 0.03) in the WBC suspension. Tasco™ did not affect the percentage of lymphocytes, but tended to increase the proportions of B cells (P = 0.08) and decrease the proportions of TCR1+ T cells (P = 0.10) within the lymphocyte population. Supplementation of Tasco™ also tended to decrease the T:B lymphocyte ratio (P = 0.11). Proportions of bovine leukocyte populations in the MGS were affected by time of sampling, but not dietary treatment. The proportion of granulocytes and macrophages/monocytes increased from parturition to d 1 (P < 0.05). The percentage of total (P = 0.03) and B (P = 0.04) lymphocytes increased from parturition to d 1. Proportions of granulocytes and monocytes/macrophages in the WBC suspension from calves tended to increase (P = 0.13 and P = 0.08, respectively) due to Tasco™ supplementation. Proportion of granulocytes in the WBC suspensions of calves increased from parturition to d 1 (P = 0.03). The proportions of CD8+ lymphocytes and B lymphocytes tended to increase in the blood of calves from birth to d 1 (P = 0.15 and P = 0.07, respectively). Dietary supplementation with Tasco™ altered proportions of bovine leukocyte populations. The impact of Tasco™ supplementation on cow and calf health requires further investigation.

Key Words: Immune response, Periparturient, Dairy

347 Forage alone pre-calving is sufficient for foraged cows post-calving. J.R. Roche, M.J. de Veth, and E.S. Kolver, *Dexcel (formerly Dairying Research Corporation), Hamilton, New Zealand.*

This study investigated the effect of diet and genotype on metabolic indicators of energy status in the periparturient cow. Fifty-six Holstein-Friesian dairy cows of two different genotypes (Northern-Hemisphere (NH) and New Zealand (NZ)) were compared. Half of each genotype group received a diet of pasture/pasture silage pre-calving and pasture post-calving (Grass). The other half received a pre- and post-calving TMR of corn silage, grass silage and concentrates. Treatments were balanced for age and genetic merit. Blood samples were collected by coccygeal venipuncture on d -14, -7, -4, -3, -2, -1, 0, 1, 2, 3, 4, 14 and 30 relative to calving. Body weight was measured weekly. NH cows were heavier at calving and lost more body weight in the first 4 weeks of lactation. This greater loss is mirrored in greater plasma non-esterified fatty acid (NEFA) concentrations 30 d post-calving. Although, Grass cows had greater (P<0.05) B-hydroxybutyrate (BHBA) concentrations pre-calving, diet did not affect the concentration of NEFA in plasma. This increased BHBA is probably due to a greater hepatic demand for gluconeogenesis as a result of poor glucose absorption in Grass cows. Plasma BHBA and glucose concentrations were unaffected by genotype. NZ cows had greater plasma cholesterol concentrations. In summary, a pre-calving TMR did not improve the energy status of the cow pre-calving. An all-forage diet pre-calving is sufficient for dairy cows fed forage post-calving.

	NZ	NH	Grass	TMR	SED	Genotype P	Feed P
Bodyweight ¹ , kg	503	590	529	563	21.0	0.001	0.111
Bodyweight ² , kg	26	40	35	30	7.8	0.086	0.485
NEFA ³ , mmol/l	0.90	0.89	0.89	0.90	0.153	0.697	0.424
NEFA ⁴ , mmol/l	0.39	0.54	0.55	0.45	0.137	0.018	0.248
BHBA ³ , mmol/l	0.72	0.60	0.64	0.68	0.105	0.161	0.439
BHBA ⁴ , mmol/l	0.62	0.62	0.73	0.52	0.177	0.935	0.079
Glucose ³ , mmol/l	4.06	4.10	4.14	4.01	0.260	0.569	0.112
Glucose ⁴ , mmol/l	3.59	3.50	3.37	3.57	0.196	0.081	0.142
Cholesterol ³ , mmol/l	2.28	1.91	2.01	2.18	0.160	0.003	0.150
Cholesterol ⁴ , mmol/l	3.87	3.60	3.03	4.03	0.290	0.001	<0.001

¹1st weighing post-calving ²bodyweight lost between d 0 and 30
³Average d 0-4 ⁴d 30

Key Words: Transition period, Periparturient cow, Metabolic indicators

348 All forage diet pre-calving improves calcium status. J.R. Roche* and E.S. Kolver, *Dexcel Ltd. (formerly Dairying Research Corporation), Hamilton, New Zealand.*

This study investigated the effect of diet and genotype on the calcium status of periparturient cows. Fifty-six Holstein-Friesian (HF) dairy cows of two different genotypes (Northern-Hemisphere (NH) and New Zealand (NZ)) were compared. Half of each genotype group received a diet of pasture/pasture silage pre-calving and pasture post-calving (Grass). The other half received a pre- and post-calving TMR of corn silage, grass silage and concentrates. Treatments were balanced for age and genetic merit. Blood samples for calcium (Ca) analysis were collected by coccygeal venipuncture on d -14, -7, -4, -3, -2, -1, 0, 1, 2, 3, 4, 14 and 30 relative to calving. Milk yields were recorded daily for 30 d post-calving. Multiparous cows fed TMR produced more milk and colostrum than Grass cows. However, colostrum yields of primiparous cows were not affected by pre-calving diet, and milk yields were greater (P=0.06) for grazing cows. This suggests that it is not the transition feeding of TMR per se that increased milk production but rather the effect of TMR during previous lactations on mammary development. NHHF had lower (P<0.05) plasma Ca concentrations post-calving than NZHF. It is possible that the lower plasma calcium concentration in TMR cows was due to a greater demand placed on the plasma pool of Ca by greater milk yields. However, plasma Ca concentration at calving also tended (P=0.08) to be lower in heifers fed TMR pre-calving, even though milk yields were lower. In summary, herds with a high proportion of NH genetics are at an increased risk of hypocalcaemia, as are cows receiving TMR pre-calving.

	NZ	NH	Grass	TMR	SED	Genotype P	Diet P
Colostrum yield, kg/day	21.1	23.2	19.1	24.9	2.05	0.317	0.006
Milk yield ¹ , kg/day	26.9	29.9	24.7	31.8	1.82	0.109	0.001
Milkfat yield ¹ , kg/day	1.34	1.37	1.23	1.47	0.097	0.732	0.016
Milk protein yield ¹ , kg/day	0.94	1.07	0.89	1.11	0.079	0.088	0.010
Plasma Ca ² , mmol/l	2.16	2.23	2.26	2.13	0.068	0.332	0.028

¹Average 5-30 d post-calving ²Day of calving

Key Words: Hypocalcaemia, periparturient cow, transition period

ASAS/ADSA Ruminant Nutrition: Water Quality and Minerals

349 The effect of water quality on the performance of feedlot cattle. J. J. Wagner^{*1}, G. H. Loneragan², and D. H. Gould², ¹Continental Beef Research, Lamar, CO/USA, ²Colorado State University, Ft. Collins, CO/USA.

Water is an essential nutrient for feedlot cattle. Drinking water may contain a variety of compounds. The important question is to what degree these substances impact water palatability and cattle health. The NRC in 1974 published limits for some potential problem causing substances in drinking water. Recommended safe upper limits for nitrate, sulfate, and total dissolved solids (TDS) were 440, 300, and 3000 mg/L, respectively. In 1999, the National Animal Health Monitoring System conducted a study monitoring water quality in feedlots with 1000 hd or more capacity in the 12 leading cattle feeding states. A total of 263 feedlots from 10 states supplied a water sample for analyses. Average nitrate, sulfate, and TDS content was 33.6±3.5, 204.9±23.5, and 800±100 mg/L, respectively. No samples exceeded the recommended limit for nitrate. Approximately 23% of the samples had sulfate concentration greater than 300 mg/L. Less than 3% of the samples had more than the recommended level of TDS. In a study conducted at Continental Beef Research, water sulfate concentrations greater than 1000 mg/L caused increases in ruminal gas cap hydrogen sulfide (H₂S) concentration and reductions in water intake and feedlot performance. Elevated ruminal H₂S was associated with increased incidence of polioencephalomalacia in a Colorado feedlot using well water containing 2500 mg sulfate per liter. Molybdenum appeared to reduce the rate of H₂S production in vitro. Molybdenum fed at the rate of 100 mg/kg dry matter intake reduced H₂S concentration in the rumen gas cap by 21% (P=0.0337) and reduced the frequency of cattle with greater than 1000 mg/L H₂S by 40% (P=0.0019). No effect on feedlot performance was observed. Cattle fed 57g clinoptilolite daily exhibited a 14.5% and a 36.3% reduction in ruminal H₂S from d0-10 and from d11-20, respectively. Feeding clinoptilolite reduced performance by feedlot cattle. Efforts to alleviate water quality problems through dietary manipulation have not been successful.

Key Words: Cattle, Water quality, Sulfate

350 Impact of variations in chemical composition of water on potential palatability and mineral intake of dairy cattle. M. T. Socha^{*1}, J. G. Linn², D. J. Tomlinson¹, and A. B. Johnson¹, ¹Zinpro Corporation, Eden Prairie, MN, USA, ²University of Minnesota, St. Paul, MN, USA.

Water is the most important nutrient for dairy cattle. However, it is probably the most overlooked nutrient. In addition to assessing adequacy and cleanliness of waterers as well as water supply, nutrition advisors need to assess chemical composition of water. This paper will summarize composition of water from samples collected throughout North America. Issues of significance with variations in chemical composition of water include the effect potential variations have on mineral intake and acceptability of water by the animal. Averages and ranges in chemical composition of 32 water samples collected were as follows: Ca, 167 ppm, 0.05 - 507 ppm; Cl, 121 ppm, 0 - 692 ppm; Cu, 0.07 ppm, 0 - 0.41 ppm; Fe, 0.23 ppm, 0.01 - 0.91 ppm; Mg, 55 ppm, 0.93 - 250 ppm; Mn, 0.091 ppm, 0.003 - 0.29 ppm; Mo, 0.08 ppm, 0.01 - 0.18 ppm; P, 0.71 ppm, 0.03 - 2.12 ppm; K, 3 ppm, 0.7 - 9 ppm; Na, 138 ppm, 7.6 - 811 ppm; S, 556 ppm, 1.2 - 1020 ppm; and Zn, 0.20 ppm, 0.01 - 0.77 ppm. For some minerals, the amount supplied by water is not insignificant. Based upon a water intake of 103.9 liters (Murphy et al., 1983 equation corrected for DM content of diet and assuming 34.0 kg milk, 22.7 kg DMI, 0.5% Na, 15.6°C and 55% DM) and the average mineral content of water given above, the following amount of minerals from water would be consumed daily: Ca, 17 g; Cl, 13 g; Cu, 7 mg; Fe, 24 mg; Mn, 9 mg; Mg, 6 g; Mo, 8 mg; P, 0 mg; K, 0 g; Na, 14 g; S, 58 g; and Zn, 21 mg. Nutrition advisors need to evaluate not only the availability of clean water on farms, but the minerals potentially supplied to animals from water. Research on mineral availability from water and how the chemical composition of water affects palatability, total water intake, animal health and performance, other than for sulfates and salinity, is very limited or nonexistent.

Key Words: Water, Dairy cattle, Chemical composition

351 Dairy manure quantification and characterization in grazing systems. J.J. Rediske^{*}, W.J. Powers, D.R. Thoreson, and M.A. Faust, Iowa State University, Ames, IA.

A 2-yr field study was conducted using two dairy herds to evaluate feeding strategy effects on nutrient excretion and volume of excretions. Holstein cows were grazed during the growing season and fed corn silage-based diets during the remainder of the year. Jersey cows were offered a corn silage-based TMR year-round but were allowed access to pasture in the growing season. Fecal excretions (24-h) were quantified using four of the ten cows with either fecal collection bags (grazing season) or fecal collection pans. Cows representing parity and stage of lactation within the herd were selected for urine and fecal sampling twice monthly. Collected samples were analyzed for solids (TS, VS), N, P and COD content. Feed and pasture samples were collected and analyzed for nutrient content. During the grazing months cows excreted significantly more feces (43.4 vs. 30.5 kg; P<.001). Fecal excretion per kg BW did not differ between herds (P>.10). Fecal TS was greater in the grazing season (16.59% vs. 15.65%; P<.001) and slightly greater in the Jersey herd (16.36% vs. 15.87%; P=.07). Fecal VS was greater in the grazing months (14.36% vs. 12.30%; P<.001) but did not differ between herds (P>.10). Urine COD was greater in the Holstein herd (35.09 g/L vs. 26.54 g/L; P<.001) but less in the grazing season (26.83 g/L vs. 34.81 g/L; P<.001). Fecal COD was greater in the Holstein herd (17.01 g/L vs. 15.44 g/L; P=.02). No seasonal differences were observed. Fecal P was slightly greater in the Jersey herd (1.69% vs. 1.27%; P=.06) and greater in the grazing season (1.72% vs. 1.24%; P=.01). Urine P was greater in the Jersey herd (252.6 mg/L vs. 169.5 mg/L; P<.001) and in the grazing season (228.0 mg/L vs. 194.2 mg/L; P=.02). Urinary N did not differ between herds; however, urine N was less in the grazing season (0.78% vs. 1.00%; P<.001). Fecal N was greater in the grazing season (2.45% vs. 2.33%; P=.04) but not different between herds. A significant herd × season effect was found for urine and fecal N and P and fecal VS, likely due to management differences. Results indicate feeding and management practices have a significant impact on nutrient and volume excretions and should serve as the basis of the nutrient planning process.

Key Words: Dairy, Manure, Grazing

352 Effect of calcium intake on phosphorus excretion in feces of lactating cows. Z. Wu^{*1}, A.G. Rius², and L.D. Satter^{1,2}, ¹University of Wisconsin, ²U.S. Dairy Forage Research Center, USDA-ARS, Madison.

The effect of dietary Ca concentration on P excretion in feces of lactating cows was determined by feeding diets containing 0.36% P and either 0.70 or 1.10% Ca, varied by calcium carbonate. The two diets were fed to 17 late-lactation Holsteins (DIM 233, SD 49) in a crossover design involving 3-wk periods. Fecal samples were collected at 3-h intervals on the last day and lactation performance was measured during the last 2 wk of each period. Increasing dietary Ca concentration from 0.70 to 1.10% increased fecal Ca concentration (P < 0.01), but did not affect fecal P concentration (P = 0.19). Milk yield (29.4 and 28.8 kg/d, SEM 0.5) and DMI (21.0 and 20.8 kg/d, SEM 0.3) were not affected (P > 0.10) by treatment. The lack of treatment effect on performance is consistent with other studies using lactating cows and growing steers that suggest a tolerance of wide Ca:P ratios by ruminants. Many dairy diets are formulated to contain Ca in excess of NRC (2001) recommendations. Reducing dietary P from the current high levels normally fed, as suggested by recent research, does not require a concomitant decrease in dietary Ca to maintain a Ca to P ratio of 2:1 for normal P absorption. This conclusion applies when normal to moderately high amounts of Ca (0.70 to 1.10%) are fed.

Item	— Dietary Ca —		SEM	P
	0.70%	1.10%		
Dietary P	— % of	DM —		
Fecal concentration	0.36	0.36		
Ca	1.68	2.43	0.13	0.01
P	0.89	0.94	0.03	0.19

Key Words: Calcium, Phosphorus, Dairy Cow

353 Effect of supplemental vitamin D on phosphorus excretion in dairy cattle. K.M. Dooley*, J.A. Bertrand, R.J. Thurston, A.B. Bodine, and T. Gimenez, *Clemson University, Clemson, SC.*

Phosphorus (P) excretion in manure is recognized as an environmental concern in the United States. The objective of this study is to reduce P excretion via increased intestinal absorption with the utilization of supplementary vitamin D (D). Repeated measures were taken in a Randomized Complete Block design experiment. Three treatments were assigned randomly to 24 Holstein cows of similar milk yield, lactation, and days in milk. A control group of 8 cows was fed both P and D at National Research Council (NRC) values of .41% DMI of P and 18,000 IU/d of vitamin D. A Low P diet for 8 cows included P at .31% DMI with no additional dietary D above NRC. The remaining 8 cows were given a treatment ration consisting of Low P (.31%) with supplemental vitamin D at 135,000 IU/d. The rations were fed for a total of 84 days. A 48-hour pre-trial collection was taken of total feces and milk along with a blood sample each 24-hour period. An additional 48-hour collection period was run at days 83 and 84. Feces and milk were weighed, sampled, and assayed for P. Serum was harvested and assayed for P and vitamin D. Fecal phosphorus (dry matter basis) in grams per day averaged 99.8g (.74%) for the control group, 83.8g (.60%) for the Low P treatment, and 86.1g (.63%) for the Low P-High D diet. Level of dietary P had a significant effect ($p < .05$) on fecal P excretion but vitamin D did not ($p > .05$). Neither P or D altered secretory P in milk ($p > .05$) or serum P levels ($p > .05$). Excess vitamin D does not appear to alter P absorption in dairy cattle.

Key Words: Phosphorus, Vitamin D, Dairy cattle

354 Effects of zinc source and dietary level on zinc metabolism in Holstein bull calves. C. L. Wright* and J. W. Spears, *North Carolina State University.*

The objective of this experiment was to evaluate the effects of zinc (Zn) source and level on Zn metabolism in cattle. Forty-eight Holstein bull calves were stratified by origin and weight, and randomly assigned to one of four treatment groups. Dietary treatments were administered in two phases. In Phase 1 (98 d), treatment groups received no supplemental zinc (Con), 20 mg Zn/kg DM as ZnSO₄ (ZnS) or ZnProt (ZnP) or 20 mg Zn/kg DM with 50% of the Zn supplied from each source (ZnM). In Phase 2 (14 d), calves continued to receive the same Zn source fed in Phase 1; however, half of the calves in each treatment group were randomly selected to receive 500 mg Zn/kg DM (HiZnS, HiZnP, HiZnM). Average daily feed intake, ADG and feed efficiency were not affected by treatment in either phase of the experiment. Treatment had no effect on plasma Zn concentration or Alp activity in Phase 1, but liver Zn concentration was greater ($P < 0.05$) in bulls fed ZnS than those fed ZnP. In Phase 2, plasma Zn was greater ($P < 0.01$) in bulls fed HiZnP and HiZnM than in those fed HiZnS, and liver Zn was greater ($P < 0.05$) in bulls fed HiZnP than in those fed HiZnS. Duodenal Zn concentrations were greater ($P < 0.01$) in bulls fed HiZnP and HiZnM than those fed HiZnS. Bulls that received ZnP and ZnM tended ($P < 0.10$) to have greater ruminal and omasal metallothionein (MT) concentrations, respectively, than bulls that received ZnS. Liver and duodenal MT concentrations were unaffected by Zn source or concentration. Bulls fed HiZnP and HiZnM had higher ($P < 0.05$) kidney Zn concentrations than those fed HiZnS. Heart, spleen, testicular, and bone Zn concentrations were unaffected by Zn source. Bulls fed ZnS had greater ($P < 0.05$) Zn concentration in hoof wall than bulls fed ZnM; however, hoof sole Zn concentration was not affected by Zn source or concentration. When Zn was supplemented at 20 mg Zn/kg DM, Zn source had minimal impact on plasma or tissue Zn concentrations. However, when Zn was supplemented at 500 mg Zn/kg DM, plasma and tissue Zn concentrations were greater in bulls that received ZnProt than in those that received ZnSO₄.

Key Words: zinc proteinate, bioavailability, cattle

355 Uptake and transport of zinc from zinc sulfate and zinc proteinate by Caco-2 cells. C. L. Wright*¹, M. L. Failla², and J. W. Spears¹, ¹North Carolina State University, ²University of North Carolina at Greensboro.

Experiments were conducted to evaluate effects of time, Zn concentration, inositol hexaphosphate (IP₆), and simulated ruminal and intestinal

digestion on the uptake and transport of Zn by Caco-2 cells, from inorganic and organic sources, using ⁶⁵Zn-labelled ZnSO₄ and Zn proteinate (ZnProt). Experiments were conducted with cells grown on plastic (uptake only) or on membrane inserts (uptake and transport). In the absence of antagonists, solubilities of Zn from both Zn sources were nearly 100%. Increasing incubation time up to 120 min and Zn concentration up to 200 μM increased ($P < 0.01$) Zn uptake and transport; however, uptake and transport were not affected by Zn source. Zinc solubility in the presence of 200 μM IP₆ and 200 μM Ca was influenced by a concentration × IP₆ interaction ($P < 0.01$), but was not affected by Zn source. In the absence of IP₆ and Ca, solubility was unaffected by Zn concentration; however, when the antagonists were added, solubility declined as Zn concentration increased. Uptake and transport of Zn in the presence of IP₆ and Ca was not affected by Zn source. Solubility of Zn following simulated ruminal and(or) intestinal digestion was not affected by Zn source. Following simulated intestinal digestion alone, uptake by monolayers grown on plastic was affected by a concentration × source interaction ($P < 0.04$). Following simulated ruminal and intestinal digestion, uptake of Zn by cells grown on inserts was affected by a source × concentration interaction ($P < 0.03$). In both interactions, uptake from the aqueous fractions of digestions containing 10 μM added Zn was not affected by Zn source; however, uptake from the aqueous fractions of digestions containing 200 μM added Zn was greater from ZnProt than from ZnSO₄. In the absence of antagonists, or in the presence of IP₆ and Ca, uptake and transport of Zn from ZnSO₄ and ZnProt was similar. Following simulated digestion, Zn uptake from ZnProt was greater than from ZnSO₄ when added at 200, but not 10 μM.

Key Words: Zinc proteinate, Caco-2, Bioavailability

356 Insulin responsiveness of adipose tissue metabolism from steers supplemented with varying concentrations of zinc sulfate. S. L. Archibeque*, G. S. Martin, G. E. Carstens, D. K. Lunt, and S. B. Smith, *Texas A&M University, College Station, TX.*

This investigation documented the interaction of supplemental dietary zinc and insulin responsiveness of acetate incorporation into fatty acids and in bovine adipocytes *in vitro*. Sixty Angus steers were backgrounded on pasture with a free-choice mineral supplement that was designed to be zinc deficient, and then were allotted to one of five different supplementation concentrations (30, 60, 120, 240, and 480 ppm) of zinc in the finishing rations. Steers were fed the treatment finishing rations for approximately 100 d (to a targeted quality grade of Select) or 140 d (Choice). Lipogenesis from 10 mM acetate was measured in flasks that contained 0, 10, 100, or 1,000 mU bovine insulin/mL incubation medium. Lipogenesis (nmol/h per 10⁵ cells) was greater in Select steers (21.3 vs 8.9, $P < 0.01$) which also had a lesser ($P < 0.01$) cell volume (300.1 vs 394.9 pL) and greater ($P < 0.01$) number of cells/g of adipose tissue (23.6 vs 17.4) than adipose tissue from Choice steers. Lipogenesis from acetate declined as zinc supplementation level increased in adipose from Select cattle, whereas the response was opposite in Choice cattle (interaction, $P < 0.03$). There was no interaction between quality grade and insulin concentration on lipogenesis. However, there tended to be an interaction ($P < 0.11$) between zinc intake and the responsiveness of lipogenesis to insulin concentration. At the 60 and 120 ppm supplemental zinc concentrations, increased concentrations of insulin in the incubation medium increased lipogenesis, whereas there was no discernible change in lipogenesis with increased insulin concentrations with tissue from cattle fed 30, 240, or 480 ppm supplemental zinc.

Key Words: Beef Steers, Zinc Sulfate, Adipose Tissue

357 Summary of eight trials evaluating the effect of feeding a combination of complexed zinc methionine, manganese methionine, copper lysine and cobalt glucoheptonate on lactation and reproductive performance of dairy cattle. D. J. Tomlinson*, M. T. Socha, and A. B. Johnson, *ZINPRO Corporation, Eden Prairie, MN.*

The objective of this review was to summarize eight trials (nine comparisons) evaluating the effect of feeding a combination of complexed zinc methionine, manganese methionine, copper lysine and cobalt glucoheptonate (4-PLEX[®], ZINPRO Corporation, Eden Prairie, Minnesota) on lactation and reproductive performance of dairy cattle. In all eight trials, cows consumed daily, 360 mg of zinc from zinc methionine complex, 200 mg of manganese from manganese methionine complex, 125 mg of

copper from copper lysine complex and 25 mg of cobalt from cobalt glucoheptonate. Cows also received additional zinc, manganese, copper and cobalt from inorganic sources. In three studies, the control and treatment diets contained an equivalent amount of zinc, manganese, copper and cobalt. In three studies, the control and treatment diets contained an equivalent amount of zinc from zinc methionine complex. In one study, two comparisons were made, complexes vs. control and complexes vs. sulfates. Six trials were conducted in conjunction with University personnel and two studies were conducted with private consultants. Each trial was a block and each treatment is mean within a trial was treated as an observation. Cows fed a combination of complexed zinc, manganese, copper and cobalt produced more ($P \leq 0.05$) milk (36.8 vs. 35.7 kg/d), energy-corrected milk (37.5 vs. 36.2 kg/d), 3.5% fat-corrected milk (37.5 vs. 36.2 kg/d), milk fat (1.33 vs. 1.27 kg/d) and milk protein (1.15 vs. 1.11 kg/d) than control cows. Cows fed the combination of complexed zinc, manganese, copper and cobalt also had fewer ($P \leq 0.05$) days to first service (74 vs. 81 d) and days open (115 vs. 133 d). This summary of eight dairy trials indicates that feeding a combination of complexed zinc methionine, manganese methionine, copper lysine and cobalt glucoheptonate increases lactation and reproductive performance of dairy cattle.

Key Words: Complexed Trace Minerals, Lactating Dairy Cows, Reproduction

358 Source of dietary selenium on tissue retention and mobilization of selenium in growing heifers. R. L. Kincaid* and J. D. Cronrath, *Washington State University*.

Diets of newborn Holstein heifers ($n = 26$) were supplemented with sodium selenite, selenized yeast (SeY, Alltech, Inc.), or no Se for 24 wk to compare efficacy of tissue retention of dietary Se. Calves were fed whole milk and starter for 5 wk, starter only for 7 wk, and starter plus hay for 12 wk. The control diet for wk 5 to 12 had 0.22 ppm Se; wk 13 to 16, 0.16 ppm Se; and wk 17 to 24, 0.12 ppm Se. Supplemented diets for wk 5 to 12 had 0.68 ppm Se; wk 13 to 16, 0.46 ppm Se; and wk 17 to 24, 0.36 ppm Se. At 16 wk of age, half of the heifers from each supplemented group were switched to the control diet to determine tissue mobilization of Se. Blood was sampled monthly and samples of liver and muscle were taken by biopsy at 16 and 24 wk. All heifers received a vaccination with a modified live virus at 20 wk. Growth rates of the heifers were not affected ($P > 0.05$) by Se supplementation. At 24 wk, concentrations of Se in blood were highest ($P < 0.05$) for heifers fed SeY (0.197 ppm), intermediate for heifers fed selenite (0.132 ppm) and least for nonsupplemented heifers (0.107 ppm Se). Likewise, muscle of heifers fed SeY had the highest Se concentrations at 16 wk (0.31 ppm for SeY vs. 0.13 ppm for selenite and controls), however, at 24 wk all Se supplemented heifers had higher concentrations of Se in muscle than the control group (0.15 vs. 0.07 ppm Se, respectively). Concentrations of Se in liver were greater ($P < 0.05$) in all heifers given Se supplements than in nonsupplemented controls. Activity of glutathione peroxidase in blood also was higher for Se supplemented heifers at wk 16 than nonsupplemented heifers. After vaccination, there were no significant differences in serum IgM and IgG among treatments. Thus, the chemical form of supplemental Se affected tissue retention of Se. By 8 wk after the Se supplements were removed from the diets, the previously supplemented heifers still had greater concentrations of Se in blood and liver than nonsupplemented controls.

Key Words: Selenium, Heifers, Tissues

359 Influence of supplemental cobalt source and concentration on performance, and ruminal plasma metabolites in growing and finishing steers. M. E. Tiffany*¹, J. W. Spears¹, and J. Horton², ¹*North Carolina State University, Raleigh*, ²*Kemin Industries, Des Moines, IA*.

An experiment was conducted to evaluate the effects of cobalt (Co) source and concentration on performance, ruminal VFA, plasma vitamin B₁₂ and glucose concentration, and carcass characteristics of finishing steers. Sixty Angus steers were stratified by weight and randomly assigned to treatment. Treatments consisted of 0 (control, analyzed 0.04 mg Co/kg), 0.05, 0.10 and 1.0 mg of supplemental Co (as carbonate)/kg DM of diet or 0.05 and 0.10 mg of supplemental Co (as propionate, KemTRACE[®] Co)/kg DM of diet. A cottonseed hull-corn-soybean meal based growing diet was fed for 56 d followed by a high concentrate finishing diet. Steers were fed individually using electronic

Calan gate feeders. Performance was not affected by Co supplementation during the growing phase. During the finishing phase ADFI was higher ($P < 0.08$), and ADG, and gain:feed were higher ($P < 0.06$) over the first 56 d for Co supplemented steers. Steers supplemented with 0.10 mg Co/kg as propionate had higher ($P < 0.01$) ruminal propionate and lower ($P < 0.02$) acetate percentages than those receiving 0.10 mg Co/kg as carbonate during the growing phase. Supplemental Co increased ($P < 0.07$) the percentage of propionate during the finishing phase. Plasma vitamin B₁₂ was higher ($P < 0.05$) in Co supplemented steers by d 56 of the growing phase and remained higher ($P < 0.06$) throughout the entire finishing phase. Steers supplemented with Co had higher plasma glucose ($P < 0.08$) at d 56 to 112 of the finishing phase and steers supplemented with 0.10 mg Co/kg as propionate had higher ($P < 0.07$) plasma glucose than those receiving 0.10 mg Co/kg as carbonate at d 28 of the growing and d 28 of the finishing phase. Hot carcass weight was lower ($P < 0.07$) in steers receiving the control diet while other carcass characteristics were not greatly affected by dietary treatment. These results indicate that diets marginally deficient in Co adversely affect performance, and vitamin B₁₂ status of finished steers.

Key Words: Cattle, Cobalt, Vitamin B₁₂

360 Lactational and reproductive responses of early lactation Holstein cows to varied levels of dietary supplementation of organic cobalt, copper, manganese and zinc. S. L. Sneed*¹, J. E. Tomlinson¹, B. L. Clark¹, E. J. Murphy, III¹, M. E. Boyd¹, and D. J. Tomlinson², ¹*Mississippi State University, Mississippi State*, ²*Eden Prairie, MN*.

Holstein cows ($n=120$) were assigned to four groups of 30 cows each based on lactation number, previous lactation ECM yield and SCC. Treatments were Control (0), 14, 28 and 56g/cow/d of supplemental organic Co, Cu, Mn and Zn provided by ZINPRO 4-PLEX[®]. 4-Plex (14g/d) provided 360 mg complexed zinc, 200 mg complexed manganese, 125 mg complexed copper and 25 mg organic cobalt. All diets were formulated to be nutritionally identical with the exception of the level of complexed Co, Cu, Mn and Zn. The control diet was formulated using inorganic sulfate forms of Cu, Mn, Zn and Co carbonate at 150 percent above NRC (1989) recommendations. Animals were placed on trial 21d prior to expected parturition ($d = 0$) and remained through 150d of lactation. Cows were housed in freestall barn with free access to TMR and water at all times. Cows were group fed 2x daily in amounts to allow for 10-15 percent refusals. Cows were milked 2x daily and milk weights recorded. Pooled milk samples (AM and PM) were taken bi-weekly for fat, protein, lactose and SCC analyses. Liver biopsy samples were taken on d -21, 7, 50 and 120 and analyzed for Cu, Mn and Zn. All liver trace mineral concentrations fell within normal ranges and showed no significant ($p > .10$) differences. Milk yield was similar across treatments; 34.0, 33.8, 35.5, 35.6 kg/cow/d for 0, 14, 28 and 56g, respectively ($p > .10$). However, milk fat percent and fat yield showed significant increases ($p < .05$). Both ECM and FCM were higher ($p < .05$) at the 56g level than both control and 14g. Milk SCC was numerically lower in cows receiving 14g/cow/d than other treatments. Supplementation of ZINPRO 4-PLEX indicated a mean decrease in days open of 12.5d and a mean decrease of 6.5d for days to first service for 14, 28 and 56g compared to 0g. In summary ZINPRO 4-PLEX increased kg of fat, percent fat, FCM and ECM, as well as decreasing days open and days to first service in lactating Holstein cows.

Key Words: Organic Trace Minerals, Trace Minerals

361 Microwave toe trimming Leghorn pullets and its effect on rearing performance. P.H. Patterson*, E.S. Lorenz, and R.M. Hulet, *Penn State University, University Park, PA.*

Previous research toe clipping day old Leghorn pullets reduced bird hysteria with no impact on feed consumption or BW to 16wk (Ruszler, 1974). Egg production was greater and mortality was reduced compared to control birds. Recently, toe trimming turkeys and broilers with a microwave technology has demonstrated reduced carcass tears and downgrading. Therefore, three Leghorn strains at 1d of age were banded and half the chicks/strain (n=75) were treated for 0.6 s with 2.45 ghz of microwave energy (NovaTech Engineering, Wilmer, MN) at the toenail cuticle of three toes/foot. The chicks were caged at 142 cm²/bird to 6wk of age. At 7d all birds were beak trimmed. At 6wk half the birds/cage were moved to a new cage increasing space to 284 cm²/bird to 18wk of age. Feed intake, BW, and mortality were recorded during the study. Within 24h after microwave treatment the chicks toenails turned white, and by 3d had sloughed off. BW at 1d, 6 and 18wk was significantly influenced by pullet strain. Microwave toe-trimmed pullets (TT) at 6 and 18wk weighed significantly less than control birds (437 vs 454g, and 1289 vs 1332g, respectively). Both strain, and treatment significantly influenced feed intake from 1d to 3wk of age. Control birds consumed 17.1^a g/bd/d compared to 14.8^b g for the TT during the same period. No significant strain, or treatment effect was observed for feed intake from 3 to 6wk of age. Initial mortality was high due to brooding challenges, but not significantly influenced by treatment or strain. Total mortality averaged 3.8% from 3 to 18wk. Body scratching was scored at 18wk of age with no scratching = 0 to severe = 4. Strain scores were significant, but low, ranging from 0.07 to 0.56. TT pullets had significantly more body scratches (0.39^a) than controls (0.24^b) although scores were low. Overall, microwave toe trimming of Leghorn pullets was associated with reduced feed intake, reduced body weight and greater body scratches than control birds. The impact on hen house performance is yet to be determined.

Key Words: Microwave, Toe, Trim

362 Drinking water treatment and dietary treatment effects on *Salmonella enteritidis* in Leghorn hens during forced molt. L.F. Kubena*¹, Y.M. Kwon¹, J.A. Byrd¹, C.L. Woodward², R.W. Moore¹, R.L. Ziprin¹, R.C. Anderson¹, D.J. Nisbet¹, and S.C. Ricke², ¹USDA-ARS, SPARC, *College Station, Texas/USA*, ²Texas A&M University, *College Station, Texas/USA*.

The layer industry uses feed deprivation to induce molting and stimulate multiple egg-laying cycles in laying hens. Unfortunately, the stress involved with this method of molting causes an increased susceptibility to *Salmonella enteritidis* (SE) under laboratory conditions and increases the risk of SE positive eggs and internal organs. There is the need for methods to stimulate multiple egg-laying cycles without the increased risk of SE. Studies were conducted utilizing Leghorn hens over 50 wk of age. The hens were divided into treatment groups of 12 hens each and placed in individual laying hen cages. One wk before water and feed changes, hens were exposed to an 8-h light and 16 h-dark photoperiod that was continued throughout the 9-day experiment. Individual hens in all treatments were challenged orally with 10⁴ cfu of SE on the fourth day. Treatments consisted of full-fed hens (non-molted, NM), non-fed hens (molted, M), M hens administered 0.25% lactic acid (LA) in the water, or hens fed a diet containing 10,000 mg zinc/kg (HZ). When compared with the NM treatment, weight losses were higher in the M, M + LA, and HZ treatments and water consumption was reduced. Crop pH and ovary weights were lower in the NM and HZ treatments, when compared to the M treatment. Cecal propionic acid and total volatile fatty acids were decreased in the M treatment when compared to the NM and HZ treatments. The number of crop and ceca culture positive hens and the numbers of SE per crop and per gram of cecal contents were higher in the M treatment, when compared to the NM and HZ treatments. This regimen or other dietary regimens may prove to be useful tools for reducing the incidence of SE in eggs and internal organs during and following molting of laying hens.

Key Words: *Salmonella enteritidis*, Laying hens-molting, Diets-zinc

363 Effect of dietary chitosan on production characteristics and egg proportions and quality from commercial white egg laying strains. K. E. Anderson*, G. S. Davis, and S. Hudson, *North Carolina State University.*

Chitin is considered the second most abundant organic resource on the earth next to cellulose, and it is derived from harvesting the waste of shellfish. Chitosan, a component of chitin, has been shown to exhibit hypocholesterolemic action and reduce cholesterol levels in rats, humans, and broiler chickens. A study was conducted to determine the effects of feeding Chitosan to egg laying hens on the egg production characteristics, quality, and proportions. The study was a randomized complete block design consisting of 4 dietary regimens. The regimens consist of the brood/grow (BG) and Layer phase (L): (1) no Chitosan fed during the BG and L (C); (2) 0.5% Chitosan fed during the BG but not in the L (TC); (3) no Chitosan fed during the BG but fed 0.5% in L (CT); (4) 0.5% Chitosan fed in BG and L (TT). The hens were placed in a layer house which contained 4 banks of tri-deck stair-step cages. Each bank of cages was designated as a block for a total of 4 blocks with 9 replicates per treatment, for a total of 882 hens per treatment. In the initial production period TT reduced yolk proportions and egg weight in contrast to the C by .89 and 3.2 g, respectively. The yolk cholesterol content was not different between any of the treatment groups. However, the cholesterol content (mg/g) of the yolk decreased from 15.2 to 12.3 mg/g as the hens aged. Feed consumption was lower (P<.05) by 0.4 kg in the birds fed Chitosan during the laying cycle. Production parameters were not effected by the feeding of 0.5% Chitosan in the diet. Egg size was shifted (P<.05) from X-Large to mediums. It was concluded that dietary Chitosan does not reduce cholesterol content on an equivalent basis but, can result in altered egg proportions and size distribution.

Key Words: Layers, Chitosan, Cholesterol

364 Effect of Termin-8[®] anti-microbial preservative on the growth of commercial white and brown egg type pullets and environmental microbial population. K. E. Anderson*¹, B. W. Sheldon¹, and K. E. Richardson², ¹North Carolina State University, ²Anitox Corp., *Lawrenceville, GA 30043.*

Farm to Table HACCP programs recommend that feed supplied to the layer industry must be free of microbial pathogens. Microbial pathogens in feed have the potential to be passed to the pullets resulting in the pullets becoming carriers of these organisms and subsequently passing the organisms onto their eggs during the production cycle. The objective of this experiment was to evaluate the feed treatment, Termin-8[®] to eliminate or reduce the microbial contamination of feed. This could benefit the layer by reducing competition in the digestive tract between indigenous and feed borne microorganisms attempting to colonize the small intestine, lowering the microbiological populations in the environment, and enhancing the pullet growth performance. The study utilized 14,976 pullets during the brood/grow period from 0 to 16 wks of age. Pullets were housed in a brood/grow facility with quad-deck cages divided into 4 rooms containing 72 replicates containing 52 birds each at a density of 310 cm² per pullet. Pullets in 2 rooms received rearing diets formulated with 2.72 kg/ton of Termin-8[®]. The pullets in the remaining 2 rooms received the same diets without Termin-8[®]. Each load of feed delivered to the farm was sampled and assayed for mold, total aerobic bacteria, enterobacteriaceae, coliform, *Salmonella* and Termin-8[®] concentration. Body weights and feed consumption data were collected from each replicate on a bi-weekly basis through 16 wks of age and environmental microbial sampling conducted every 4 wks. Treatment of the feed with Termin-8[®] resulted in a reduction (P<.05) of pullet body weight and lower overall feed consumption compared to the control. Mortality was also lower in the brown egg pullets receiving Termin-8[®]. Bacterial counts in the control and treated feeds averaged 3261 cfu/g and 413 cfu./g respectively over the course of the trial. The environmental microbial counts were altered in the rooms containing pullets on the Termin-8[®] supplemented feed. These results suggest that treating the feed with Termin-8[®] reduced microbial contaminants, which was associated with a subsequent positive impact on the pullets growth and feed consumption.

Key Words: Layers, Microorganisms, Termin-8[®]

365 Effect of a feed additive or manure treatment application on the mass generation rate of ammonia produced from laying hen manure. K.W. Koelkebeck*, P.C. Harrison, and G.L. Riskowski, *University of Illinois, Urbana, IL USA.*

An experiment compared the ammonia generation rate from laying hen manure that received an ammonia production inhibitor which worked systemically (through the feed) to a topically applied compound. Eighty-one mature laying hens (56 wk of age) housed in a cage layer facility were divided into three treatments with three replicates each. The treatments were: 1) control, 2) systemic (Micro-Aid[®] in the feed), and 3) topical (Al⁺ Clear[®] sprayed on the manure daily). The application rate of the topical ammonia inhibiting compound was evenly applied as a liquid spray (161.3 g/m²) daily. Hens in the systemic treatment had received the feed treatment for three months prior to the start of the experiment. These treatments were applied for two weeks and ammonia generation rate was measured at Day 1, 7, and 14 following the start of the experiment. The mean overall mass generation rate of ammonia for the two week period of manure collection was 67, 60, and 36 mg NH₃/hr/kg manure for the control, systemic, and topical treatments, respectively. Ammonia generation rate from manure on Day 1, 7, and 14 was the lowest for the topical treatment. Treatments had no effect on manure weight or moisture; however, when ammonia generation rate was compared on a dry weight basis for the 14-d evaluation, the systemic and topical treatments were 17 and 26% lower, respectively, than the control. Thus, these data indicate that the mass generation rate of ammonia production from laying hen manure may be depressed by using a topical manure treatment.

Key Words: Ammonia Generation Rate, Manure Treatment Application, Ammonia Production Inhibitor

366 Interaction of increased Ca and P regimens on commercial strains of layers housed at various densities. M.H. Fosnaught* and K.E. Anderson, *North Carolina State University.*

It is established that nutrient recommendations of layers vary with strain. As layers are being housed at lower density due to animal welfare concerns, nutrient requirements will also vary. Hens housed at lower density generally consume more feed and have greater egg production. Ca and P levels, critical for optimal layer health and production, should be considered in light of not only strain but stocking density. Therefore, two strains of hens were fed two levels of Ca and P while kept at two densities from 18-66 wks of age and evaluated for performance. This 2X2X2 factorial utilized 5,824 hens (14 reps/trt) which were housed in environmentally controlled, stair step cages. The two strains (Hy-Line W-36 (H) and Babcock 300 (B)) were fed two levels of Ca and P (constant Ca and P or control (C) and increasing Ca and P (CaP+)) while housed at two densities (low density (LD or 413 cm²/hen) and high density (HD or 310 cm²/hen) both at 4 birds/cage). Feed cons was measured every 4 wks and egg production daily. Strain and density affected ($p < .05$) most production parameters measured. The H strain compared to B had lower feed cons/100 hens (9.7 vs. 10.3 kg, $p < .01$) and lower hen day production (80.1 vs. 81.3 %, $p < .01$). The LD vs. HD showed lower feed cons/100 hens (10.4 vs. 9.5 kg, $p < .0001$) and higher hen day production (82.9 vs. 78.5 %, $p < .0001$). The finding of particular interest was a significant three-way interaction between strain, Ca and P, and density ($p < .05$). Hens responded similarly to the CaP+ regimen when kept at HD regardless of strain. However, if these hens were housed at LD then the H strain responded favorably to the CaP+ regimen while the reverse response was observed for the B strain. At LD, the H vs. B strain when fed CaP+ consumed less feed/100 hens (9.98 vs. 10.91 kg, $p = .05$), improved FE (.47 vs. .45 g egg/ g feed, $p = .05$), elevated eggs/hen housed (272 vs. 265 eggs, $p = .02$) and increased egg income (\$16.10 vs. \$15.64, $p = .04$). Reevaluating the need of layers for Ca and P when housed at lower stocking densities may be more strain dependent than previously realized. Therefore, as shifts are being made to lower density such as in many European production systems, further research may be necessary to determine optimal nutritional requirements of different strains.

Key Words: Layers, Calcium, Density

367 The effects of dietary protein and available phosphorus on production measures and nutrient excretion by egg-type hens from 21 to 36 weeks of age. R Reed*, J. Nixon, and M. Lilburn, *The Ohio State University/OARDC.*

From 21 to 36 weeks of age, commercial egg-type hens (Hyline W-36) were fed diets containing two levels of calculated available phosphorus (AvP; .25%, .42%) and two levels of dietary crude protein (CP; 14.9%, 16.5%). There were also two combinations of phytase supplementation (0, 300) for a total of 6 possible dietary treatment combinations. The experiment was broken down into four, 28-day production periods and all data was analyzed within each period. During the last week of each production period, feed intake was determined and excreta was collected for nutrient analysis. Egg production was recorded daily and all eggs were collected and weighed during the last week of each production period. These eggs were used for shell weight determination. There were no consistent treatment main effects (AvP, CP, Phytase) on feed intake but the low AvP treatment did result in significant increases in BW over the last 3 experimental periods. The low AvP level resulted in increased egg production over all 4 experimental periods whereas the high CP diets resulted in consistent increases in egg wt over all production periods. There were no other consistent main effects or significant two-way interactions. There were no consistent main effects on shell weight although supplemental phytase did significantly reduce shell wt during periods 2 and 3. Excreta P was significantly increased in all production periods with increased dietary AvP and there were no significant effects due to phytase supplementation. During the last production period, there was an AvP by phytase interaction resulting from less excreta P in the low AvP treatment supplemented with phytase. The high CP diets resulted in increased excreta N but there were no other main effects or interactions. It is important to note that while not significant ($P \leq .063 - .192$), there was a consistent increase in excreta P associated with the high CP diets, most likely due to the increased soybean meal necessary to achieve the higher levels of CP.

Key Words: Phytase, Phosphorus, Manure

368 The effect of claw and beak reduction on growth parameters and fearfulness of two Leghorn strains. C. N. Ferst*¹ and P. L. Ruzsler¹, ¹*Virginia Tech.*

Commercial equipment being used by the turkey industry reduces claw growth and trims the beak without physical invasion of body tissue. To test the effects of this technique on chickens, one-half of two strains of 1250 Leghorn chicks each were subjected to the claw reduction technique (CR) using microwave energy that kills the germinal cells at hatch. The other half retained normal claws (NC). The beaks of 1/3 of the chicks were reduced at hatch using an infra-red energy technique; one-third were precision beak trimmed at 7 days and one-third were not trimmed. Body weight, feed intake, mortality and fearfulness were measured weekly and biweekly until housing at 20 weeks in laying cages. Rearing followed standard commercial feeding and husbandry procedures using 10-20 lumens of light and fed *ad libitum* a 20% starter with 2926 kcal; 17% grower, and 15% developer with 2860 kcal/kg. Body weights were equal to or greater than breeder standards throughout the trial, being 2 weeks advanced at 16 weeks of age. There were no statistically significant differences between treatments in body weight. However, the chicks with beak reduction at 1 day of age experienced consistently lower body weight numerically from 3 to 14 weeks of age and also ate less total feed at the 0.08 level of significance by 14 weeks of age and thereafter. Mortality was less than 1.3% throughout the trial. Fearfulness was being expressed in the NC treatment by 5 days of age, continuing to a peak of 8-10 points at 6-8 weeks of age on a subjective scale of 1 (calm) to 10 (total fear). The CR treatment expressed a fearfulness level of only 3-4 points at 6-8 weeks. Expressed fearfulness later subsided to levels of 2-3 for CR and 6-8 for NC birds by 16-18 weeks. The larger body size of older birds filling the cage space appears to reduce the expression of fear. Reducing the claw growth and beak development during the growing period showed that pullets can be raised on less total feed and without the usual level of fearfulness by improving the environmental climate in the cage.

Key Words: Claw & Beak, Fearfulness, Body weight

369 Growth Response of a *Salmonella typhimurium* Poultry Isolate to Zinc Addition. S. Y. Park*¹, C. L. Woodward¹, S. G. Birkhold¹, L. F. Kubena², D. J. Nisbet², and S. C. Ricke¹, ¹Texas A & M University, College Station, Texas, USA, ²USDA-ARS, Food and Food Safety Research Unit, College Station, Texas, USA.

It has been shown that induced molting by complete feed withdrawal increases *Salmonella* horizontal transfer in laying hens and contamination in eggs. Zinc-containing diets have been used as an alternative means to induce molt in laying as a management while avoiding feed withdrawal. It is not known if the zinc in these molt diets would inhibit *Salmonella* spp. growth and therefore potentially minimize the *Salmonella* spp. infection in individual hens. The objective of this study was to examine the effects of zinc concentration on a primary poultry isolate of *Salmonella typhimurium* growth from either nutrient rich or minimal media after inoculation. zinc sulfate (ZnSO₄) concentrations (0.67%, 2.01%, 3.35%, 4.69%, and 6.03%) were added to either 5ml of tryptic soy broth (TSB) or M9 broth after inoculation of overnight fresh culture. The growth of *S. typhimurium* poultry isolate in individual tubes at 37 °C was measured by as optical density (A₆₀₀) on a spectronic 20D spectrometer. Growth rate was determined by linear regression of change in natural logarithm of A₆₀₀ during exponential growth. Growth rate of *S. typhimurium* poultry isolate was significantly (P<0.05) decreased by the presence of zinc sulfate in M9 at concentrations greater than 2.01%. Zinc added to M9 broth at the same concentrations was much less inhibitory to *S. typhimurium* poultry isolate growth rates. The results indicate that the higher concentrations of zinc addition may be effective by inhibiting *Salmonella* spp. growth.

Key Words: *S. typhimurium*, Molting, Zinc

371 Minimal available phosphorus requirement of molted laying hens. J.L. Snow*, M.W. Douglas, A.B. Batal, M.E. Persia, P.E. Biggs, and C.M. Parsons, *University of Illinois, Urbana, IL USA.*

In an effort to diminish excessive feeding of phosphorus, our objective was to determine the minimal available phosphorus (AP) requirement for hens being molted and kept for two egg production cycles. Six replications of Dekalb Delta hens were fed diets (17% CP, 3.8% Ca) containing 0.10, 0.12, 0.14, 0.16, 0.18, 0.20 or 0.45% AP starting at 21 wk of age. Diets containing 0.10, 0.12, and 0.14% AP were terminated at 35, 39, and 50 wk, respectively, due to low egg production and increased mortality. The remaining hens were then induced molted at 64 wk of age by 10 d feed removal. Following feed removal, three replications from each previous AP level were fed either a 100% corn (C) diet or a nutritionally complete (NC) molt diet (16% CP) for 16 d. The hens were then returned to the same AP layer diet they had been fed from 21 to 64 wk. Egg production performance will be measured from 68 to 110 wk of age, with data for only the 68 to 87 wk period being reported here. During the molt period, mean body weight loss at the end of the 10 d feed removal was 22%. As expected, hens fed the NC molt diet returned to egg production faster and had significantly higher body weight gains than birds fed the C molt diet. For the 68 to 87 wk postmolt period, hens fed the 0.16% AP (163 mg/d) diet had significantly lower egg production and egg mass yield compared to hens fed 0.45% AP (P<.05). Although there were no significant (P>.05) differences in egg production among the other treatments, egg production and egg mass yield were numerically lower (P≤.1) and mortality was higher for hens fed 0.18% AP (185 mg/d) versus those fed 0.45% AP. There were no significant differences in body weight or egg weight among any treatments. Our results suggest that molted hens in their second lay cycle require approximately 0.20% AP or 210 mg AP/d. This requirement is higher than what we determined in several previous experiments for first cycle, nonmolted hens.

Key Words: Available Phosphorous, Requirement, Molting

370 Use of an alfalfa diet for molting in Leghorn hens to reduce *Salmonella enteritidis* colonization and invasion. Y.M. Kwon*¹, L.F. Kubena¹, C.L. Woodward², J.A. Byrd¹, R.W. Moore¹, D.J. Nisbet¹, and S.C. Ricke², ¹USDA-ARS, SPARC, College Station, Texas/USA, ²Texas A&M University, College Station, Texas/USA.

The standard method for molting to stimulate multiple egg-laying cycles in laying hens is feed deprivation. However, the environmental changes within hens caused by feed deprivation are known to increase susceptibility of the hens to *Salmonella enteritidis* (SE) infection. In an effort to develop an alternative method to induce molting without increasing susceptibility to SE, an alfalfa diet was compared with the standard molting method for the level of molting and SE colonization. Hens over 50 wk of age were divided into three treatment groups (12 hens/group); non-molting by normal feeding (NM), molting by feed deprivation (MO), and molting by alfalfa diet (AD). The individual hens in all treatments were challenged orally with 10⁴ cfu of SE on the fourth day after feed changes, and analyzed for ovary weight and SE colonization or invasion in crop contents, cecal contents, liver, spleen, and ovary on the ninth day. In ovary weight, AD (4.8 g) was not different from MO (6.9 g) but was significantly lower (P = < 0.05) than NM (27.5 g), indicating the molting was possibly as successfully induced in AD as in MO. However, the total number of SE positive organs for all of the organs determined by enrichment technique was decreased in AD (10/60) as compared to MO (46/60), while no colonization was detected in NM (0/60). The trends of SE reduction in AD as compared to MO were consistent with all of the organs analyzed. Therefore, the results of this study suggest that an alfalfa diet has the potential to be used as an alternative method for forced molting, without increasing the incidence of SE in eggs and internal organs.

Key Words: *Salmonella enteritidis*, Laying hens-molting, Alfalfa diet

PSA Nutrition: Feed Regimens

372 The effect of various levels of vitamin E supplementation in the diets of laying hens on egg yolk alpha-tocopherol content and hen performance. R. C. Johnson*¹, J. C. Hermes¹, R. Kampen², and A. M. Craig¹, ¹Oregon State University, Corvallis, OR, ²BASF, Abbotsfort, BC, Canada.

Two experiments were conducted to determine the effect of high levels of vitamin E in the diet of laying hens on egg yolk alpha-tocopherol content and hen performance. In experiment 1, 192, 50+ week old hens were fed one of 12 experimental diets formulated to contain 5, 10, 15, 20, 25, 100, 200, 250, 350, 400, 550, or 700 IU/kg of alpha-tocopherol for 4 weeks. Hens were selected at random, housed in individual cages and separated into four replicate treatment groups with four hens per treatment (n = 16). Daily egg production was determined along with weekly analysis of body weight, egg weight, albumen height, yolk color and yolk alpha-tocopherol content. Only egg weight and yolk alpha-tocopherol showed significant differences between dietary treatments. In experiment 2, 96 laying hens, 33 wks of age, were allocated into groups and housed as in experiment 1. The diets were formulated to contain either 15, 250, 1000, 2000, or 3000 IU/kg of vitamin E. Data collected was similar to experiment 1. After consuming the diets during the four weeks of the trial, the hens produced average egg yolk alpha-tocopherol levels of 153, 356, 607, 684, 1549, and 1394 µg/g, respectively. Results with significant differences include egg weight (P<.002), albumen height (P<.002), yolk color (P<.0001), yolk weight (P<.01), and the number of eggs produced per diet (P<.021). In both experiments, the vitamin E level in the feed significantly increased the alpha-tocopherol content in the yolk (P<.05). No signs of alpha-tocopherol toxicity were noticed at necropsy following the experiment.

Key Words: Vitamin E, Egg vitamin content, Layers

373 Nutrient requirements of Hy Line W-36, Bovans White and a new strain of Bovans White hens for optimum profits during phase I. A. Bateman*¹, M. Bryant, and D. A. Roland, Sr., ¹Auburn University.

A study was conducted to compare performance and nutrient requirements of a new strain of Bovans White hen with the previous strain of Bovans White hen as well as Hy Line W-36 hens (weeks 21-36). Three

diets were used in each of the three strains for a 3 x 3 factorial arrangement. One diet was formulated based on protein (P-20) and contained 1.02% lysine and 18.70% protein, while two diets were formulated based on lysine which contained either 0.83% lysine and 16.19% protein (L-20) or 0.92% lysine and 17.34% protein (L-18). The criteria used were egg production, feed consumption, egg weight and egg specific gravity. Diet and strain of bird significantly effected ($p < 0.05$) egg production and egg weight. Both strains of Bovans had higher egg weight and production compared to the Hy Line W-36. Diet also had a significant effect on egg production and egg weight. Hens fed the P-20 diet had the highest egg weight and production, followed by the L-18 and the L-20. Feed consumption, egg specific gravity and feed conversion were significantly effected by strain. The old strain of Bovans had the highest feed consumption, followed by the new Bovans and the Hy Line W-36. The new strain of Bovans had the highest egg specific gravity and best feed conversion, followed by the old Bovans and the Hy Line W-36. Among the three strains, the most profits were obtained with the new strain of Bovans White. For optimum profits during phase I, the new Bovans required 998 mg lysine, 714 mg TSAA and 18.30 g protein per hen per day. These values are higher than the 690 mg lysine, 580 mg TSAA and 15 g protein per hen per day recommended by the National Research Council (NRC).

Key Words: Feed formulation, Bovans White, Profits

374 Feeding and management of Bovans White hens for optimum egg size and profits during phase I using warm temperatures. A. Bateman^{*1}, S. Yadalam, M. Bryant, and D. A. Roland, ¹Auburn University.

A study was conducted to determine the most economical nutrient (protein and lysine) level to feed during phase I (weeks 21-36) to optimize egg weight and profits when hens were exposed to warm temperatures (25.56°C average). Nine hundred and sixty 21-week old hens were randomly divided into six groups of 160 hens per group. Diets were formulated based on protein as well as lysine. The three diets formulated based on protein (0.90%, 1.02% and 1.17% lysine; 17.00%, 18.70% and 20.80% protein) each contained 2871 kcal ME/kg. The three diets formulated based on lysine (0.75%, 0.83% and 0.92% lysine; 14.98%, 16.19% and 17.34% protein) each contained 2834 kcal ME/kg. The criteria used were egg production, feed consumption and egg weight. Neither the diet or the method of formulation had a significant ($p > 0.05$) effect on any of the criteria other than egg weight. As the lysine (or protein) content of the diets increased, egg weight was significantly ($p < 0.05$) increased. Egg weight was also significantly ($p < 0.005$) higher in the diets formulated based on protein versus the diets formulated based on lysine. Egg production peaked at greater than ninety-five percent in birds in all treatments at 33 weeks of age, and remained over eighty-eight percent for the remainder of the study. Using an economic analysis, it was shown that for optimum profits Bovans White hens required 1,076 mg lysine, 750 mg TSAA and 19.1 g protein per hen per day during phase I. These values are higher than the 690 mg lysine, 580 mg TSAA and 15 g protein per hen per day recommended by the National Research Council (NRC).

Key Words: Feed formulation, Bovans White, Profits

375 Evaluation of non-feed removal versus feed removal methods for molting programs. P.E. Biggs^{*}, M.W. Douglas, K.W. Koelbeck, and C.M. Parsons, *University of Illinois, Urbana, IL USA.*

The objective of this study was to determine the effects of feed removal versus feeding high corn or wheat middlings diets as induced molting techniques. An experiment was conducted using 336 White Leghorn hens (60 wks of age) randomly assigned to one of four treatments that consisted of feed removal for 4 or 10 d or no feed removal with *ad libitum* access to 95% corn or 95% wheat middlings molt diets containing supplemental vitamins and minerals. At the end of the 4 or 10 d feed removal period, hens on these treatments were provided with the corn molt diet for 24 or 18 d, respectively. Hens on the corn or wheat middlings treatments were fed the diets for 28 d. At 28 d, hens on all treatments were fed a corn-soybean meal layer diet (16% CP). Both feed removal and the wheat middlings treatments resulted in total cessation of egg production within 8 d. Egg production of hens fed the corn molt diet had decreased to 3% by 28 d. Body weight loss for hens fed the corn or wheat middlings diets was approximately 9% at 28 d. Hens fed the

wheat middlings diet returned to production slightly faster than hens on the other treatments. Post-molt egg production (6 to 28 wks after initiation of the molt treatments) was generally higher for the wheat middlings and 10-d feed removal treatments than for the corn and 4-d feed removal treatments. Average feed intake for Weeks 2 to 4 during the molt period and Weeks 5 to 8 on the layer diet was highest ($P < 0.05$) for the wheat middlings treatment, with all other treatments being similar during these periods. No differences in feed intakes were observed among treatments after Week 8. There were no consistent differences in mortality, post-molt egg weight, egg specific gravity, and Haugh units among treatments. This research indicates that feeding high corn or wheat middlings diets, particularly wheat middlings, are effective non-feed removal methods for molting hens.

Key Words: Induced Molting, Feed Withdrawal, Laying Hens

376 The effect of midnight feeding on feed consumption and eggshell quality in commercial laying hens. A. Petruk^{*1}, D.R. Korver¹, R.A. Renema¹, and M.J. Zuidhof², ¹University of Alberta, ²Alberta Agriculture, Food, and Rural Development, Edmonton, AB, Canada.

The effect of allowing laying hens access to feed for 1 hour at midnight to prevent perturbations in eggshell quality and calcium status was investigated. Two trials were performed using 60 wk old SCWL Shaver 2000 hens (48 hens/experiment). Experiment 1: The hens were exposed to midnight feeding for 27 weeks prior to the study. Half of the hens ($n=24$) were allowed continued midnight feeding (MF treatment) while the other half ($n=24$) had their feeder removed at 2000h and replaced at 0500h to prevent overnight feed intake (CONT treatment). Experiment 2: Experimental conditions and treatments were as described in Experiment 1, except the hens had no prior exposure to midnight feeding. Daytime (0500h to 2000h), night (2000h to 0500h) and total daily feed consumption were recorded daily for each hen; BW was recorded weekly. All eggs were collected and shell quality assessed. Egg specific gravity, yolk weight, and dry shell weight were measured 3 times/wk. The MF hens in Experiment 1 gained more weight than CONT birds (MF, 49.30g; CONT, -15.52g) and relative gain was also higher (MF, 2.51%; CONT, -0.77%) with no differences in Experiment 2. Egg production did not differ in either study, although differences in total (MF, 26.87; CONT, 23.70) ($P = 0.0573$) and settable (MF, 26.61; CONT, 23.39) ($P = 0.0600$) egg production rates approached significance in Experiment 1. Egg weight, shell weight, specific gravity, and yolk weight showed no differences in either experiment. In Experiment 1 (prior exposure to midnight feeding) there were no treatment differences in daytime or total weekly feed consumption. In Experiment 2 (no prior exposure to midnight feeding) daytime consumption of the CONT hens was higher for every week of the study, demonstrating that MF hens had shifted their feeding patterns. Specific advantages of a midnight feeding program on shell quality or egg production were not demonstrated under the experimental conditions of this study.

Key Words: Midnight feeding, Feed consumption, Eggshell quality

377 Effects of commercial strain, dietary sodium bicarbonate level, or animal fat versus vegetable oil addition to feed on performance of caged White Leghorn laying hens from 36 to 48 weeks old in summer. L. R. Minear^{*1}, D. M. Hooe², and K. R. Cummings, ¹Southern States Cooperative, Richmond, VA, ²Hooe Consulting Service, Inc., Eagle Mountain, UT, ³Church & Dwight Company, Inc., Princeton, NJ.

About 6,336 caged White Leghorn hens, 36 wk of age, were used in a 12-wk trial to evaluate effects of strain (Hy-Line W-98, HYL; Bovans, BOV) and dietary treatments in a 2 x 5 factorial arrangement. Phase II diets were: 2.5% animal fat (AF) control basal (CON); CON basal with 0.3, 0.4, or 0.5% level of sodium bicarbonate (SB) in place of an equal amount of brewers grains, with corn and soy adjustment; or 2.5% vegetable oil (VO) feed. The practical corn-soy, brewers grains based diets contained BASF phytase, limestone, and oyster shell. All feeds were formulated to contain calculated potassium (K) and chloride (Cl) levels of 0.71% and 0.21%, respectively, whereas calculated sodium (Na) varied from 0.174% in CON to 0.261, 0.349, and 0.436% in the respective sodium bicarbonate diets. Dietary electrolyte balances, Na+K-Cl in mEq/100 g, were about 19.7 (animal fat or vegetable oil basal diets), 23.2, 24.4, and 25.6, respectively. There were 160 experimental (replicate) units with around 40 hens each (4 or less/conventional cage).

Stocking density was about 0.039 m²/hen. The study was conducted in Virginia from July through September. Significance was by LSD (T method) at P<0.05. The HYL layers had higher livability, feed/dozen eggs, egg weight, albumen weight, and wet shell weight, but lower hen-day egg production and yolk weight than BOV laying hens, with no differences in daily feed intake or egg mass output. The VO supplement tended to increase egg weight (P=0.18) and albumen weight (P=0.11) compared to AF addition. Increasing levels of SB increased feed intake, feed/dozen eggs, feed/kg egg, and yolk weight compared to CON. This increase in feed intake in summer with SB may be due to partial replacement of Cl by HCO₃ in blood lowering dietary "effective Cl" level (as increasing Cl depresses feed consumption based on previous research) or to additional Na increasing water intake and bird cooling, or both. Yolk weight increased from 16.8 to 17.1 g with 0 vs 0.3% SB when feed intake correspondingly increased from 97.2 to 98.7 g/hen/day, associated with +0.018 kg feed/dozen eggs and +0.010 kg feed/kg eggs. Dietary SB at 0.3 to 0.5% increased feed intake and yolk weight, with slight increases in feed per dozen or per kg of eggs in summer.

Key Words: Animal fat, Sodium bicarbonate, Vegetable oil

378 Evaluation of phytase release factors in broiler diets containing different levels of amino acids. W. Pan*, F. Yan, C. A. Fritts, and P. W. Waldroup, *University of Arkansas.*

In addition to its effects on release of phytate-bound P in poultry diets, phytase may release additional nutrients such as amino acids and carbohydrates making more energy available to the chick. However, the research supporting this additional nutrient release is inconsistent and controversial. A study was conducted in which a series of diets with minimum amino acid (AA) levels ranging from 85 to 115% of NRC (1994) recommendations were formulated 1) without consideration of the nutrients released by phytase; and 2) considering the nutrients released by 600 units/kg of phytase (Natuphos[®] BASF). Calcium and nonphytate P were at levels suggested by the NRC, also taking into consideration the release of these nutrients by phytase. Therefore performance should be equal on diets with and without phytase supplementation if the nutrients are released. Each diet was fed to six replicate pens of 25 male chicks maintained in litter pens. Body weight and feed conversion (FCR) were determined at 21 and 42 d. At 42 d tibia were taken from 5 birds per pen. The left tibia was ashed and the right tibia scored for incidence and severity of tibial dyschondroplasia (TD). Overall, performance of chicks fed diets with or without phytase did not differ significantly for any measurement. Performance was influenced by dietary AA level, and there was a significant interaction of AA level x phytase supplementation for BW and FCR with addition of phytase improving performance at some AA levels, depressing performance at other levels, and being equal at some levels. The AA levels significantly influenced the incidence and severity of TD. Tibia ash was not significantly influenced by AA levels or by phytase supplementation. These data suggest that the nutrient release factors might be used when supplementing diets with phytase but results may be highly variable.

Key Words: Phytase, Nutrient release, Amino acids

379 Effects of glycine and threonine supplementation on performance of broiler chicks fed diets low in crude protein. Qi Jiang*, C. A. Fritts, and P. W. Waldroup, *University of Arkansas, Fayetteville, AR.*

Reduction of crude protein by use of crystalline amino acids has been successful to a point but performance eventually declines. Previous work from our laboratory indicates that reducing CP in broiler starter diets below 20% adversely affects performance even though essential amino acids were more than 110% of NRC (1994) recommendations. In recent studies we determined that additional Gly but not Pro, Arg, or Glu improved performance on diets low in CP. The present study investigated the use of both Gly and Thr at levels in excess of NRC recommendations. Diets based on corn and soybean meal were formulated to contain from 16 to 24% in 2% increments. All essential amino acids were at 100% of NRC recommendations with lysine at 110%. Crystalline amino acids were added as needed. The treatments consisted of the five levels of CP, three additional levels of Gly (0, 0.2, 0.4%) and three levels of Thr (0, 0.2, and 0.4%) in all possible combinations. Each diet was fed to six pens of 6 male broiler chicks in battery brooders. Diets with 20% or less CP resulted in significant reduction in BW and feed conversion even though meeting all known amino acid requirements. Addition of Gly but

not Thr significantly improved BW, especially at the lower CP levels. However performance was still less than obtained on diets with 22 and 24% CP. These data suggest that other amino acids may be deficient in diets low in CP.

Key Words: Glycine, Threonine, Broilers

380 Efficacy of Ronozyme PTM liquid phytase and Natuphos[®] liquid phytase in broiler starter diets. J. Broz¹, A. Klunter¹, N.E. Ward*², and J.W. Wilson², ¹*Roche Vitamins, Basel, Switzerland,* ²*Roche Vitamins Inc., Parsippany NJ.*

Two similarly-designed experiments compared Ronozyme PTM Liquid (RL) and Natuphos[®] Liquid (NL) for broilers taken to 22 days of age. Day-old Ross chicks were fed a low phosphorus (P), mash, corn/SBM diet through day 8, after which the birds were allocated by weight to one of three diets: negative control (NEG; 0.51% total P, 0.76% Ca); RL, 500 FYT/kg in NEG; NL, 500 FTU/kg in NEG. Eight (8) replications/treatment (4 groups of males, 4 groups of females) were fed through day 22. Excreta was collected from days 14-17 to determine apparent P and calcium (Ca) retention.

There were no treatment x sex interactions (P>.05), thus data were pooled across sexes. Results for the second experiment mirrored those of experiment 1. Body weight and F/G (adjusted for mortality) were improved (P<.05) with both phytase sources, whereas mortality was unaffected (P>.05) by trt. P and Ca retention were increased (P<.05) by phytase treatments. P and Ca in excreta were decreased (P<.05) equally (P>.05) by the addition of either phytase source to the diet. For both experiments, 500 units phytase/kg diet from either source were found to be equivalent for all variables tested.

Variable	NEG	RL	NL
Phytase, analyzed units/kg	-	618	665
Body wt. gain g/bird	477 ^b	501 ^a	512 ^a
F/G	1.564 ^a	1.526 ^b	1.509 ^b
P-retention g/bird/day	0.157 ^b	0.183 ^a	0.194 ^a
Ca-retention g/bird/day	0.231 ^b	0.279 ^a	0.294 ^a

NEG = negative control; RL = RonozymeTM P Liquid; NL = Natuphos[®] Liquid; ab P<.05

Key Words: Ronozyme PTM Liquid, Phytase, Broilers

381 An evaluation of Ronozyme PTM CT in broiler diets in a 36-day floorpen study. J. Broz¹, A. Klunter¹, N.E. Ward*², and J.W. Wilson², ¹*Roche Vitamins, Basel, Switzerland,* ²*Roche Vitamins Inc., Parsippany NJ.*

This 36-day floorpen study was designed to compare two commercial sources of dry phytase in a corn/SBM diet. Ronozyme PTM CT (RCT) was added to provide 500, 750 and 1,000 FYT/kg feed, while Natuphos[®] G (NG) was added at 500 FTU/kg diet. All treatments were cold-pelleted to minimize destruction of NG. Each treatment was replicated 8 times with 20 birds/replication (4 groups of each sex). The negative control (NEG) diet, to which each phytase treatment was added, contained 0.51% total P and 0.83% Ca. A positive control contained 0.61% total P and 0.91% Ca.

There were no (P>.05) treatment x sex interactions, thus all groups were pooled for data evaluation. Analyzed phytase values post-pelleting were in agreement with target values, excepting RCT 1,000 FYT/kg, which appeared erroneous based on actual addition rate. Supplementation of phytase increased (P<.05) body weights and feed intake over that of NEG, but no difference (P<.05) was noted across phytase source. F/G of RCT (750 FYT/kg) was improved (P<.05) over that of NG (500 FTU/kg), while no difference existed within RCT levels. Mortality was unaffected (P>.05) by treatment. Day 36 tibia ash did not differ (P>.05) across phytase level or source, but the addition of phytase increased (P<.05) bone ash over NEG. Over a 36-day period, the two sources of phytase at 500 units/kg were not different (P<.05) for any variable tested, although there was a tendency for RCT to more favorably influence F/G.

Variable	NEG	RCT-500	RCT-750	RCT-1000	NG-500	POS
Analyzed phytase, units/kg	140	479	734	787	516	111
Body wt., g	1800c	1920b	1965ab	1962ab	1945b	2026a
Feed intake, g	2708c	2894b	2936b	2941b	2964b	2137a
F/G	1.506bc	1.508bc	1.497c	1.502bc	1.526ab	1.545a
Mortality, %	3.1	7.5	4.4	5.0	5.6	3.8
Tibia ash, % dry matter	49.7c	51.6b	51.6b	52.3ab	51.8b	53.1a

NEG, negative control; RCT, Ronozyme PTM CT; NG, Natuphos[®] G; POS, positive control; abcP<.05

Key Words: Ronozyme PTM CT, Natuphos[®] G, Floorpen broiler study

382 Reassessment of Trypsin Inhibitor Activity in Guar Meal. S.R. Conner*, A.L. Cartwright, and C.A. Bailey, Texas Agricultural Experiment Station.

Guar (*Cyamopsis tetragonoloba*) is a drought resistant annual summer legume grown primarily for its galatomannan polysaccharide gum. In the separation of the gum containing endosperm, two distinct fractions are obtained. The first fraction from the splitting of the guar bean has higher germ content and the second fraction removes the hull from the remaining gum containing endosperm. A third fraction results from a combination of the two fractions. Although guar meal can be used as a source of vegetable proteins in animal feeds, a major impediment to protein digestibility is commonly attributed to a trypsin inhibitor. Defatted raw soybeans, dehulled soybean meal and three guar fractions evolved from various stages of guar gum production were assayed for trypsin inhibitor activity using the American Oil Chemists' Society official method Ba 12-75. Results indicated that the trypsin inhibitor

activity of the raw guar beans, guar splits (gum), and the three guar meal fractions were substantially less than the trypsin inhibitor activity of heat treated dehulled soybean meal. Trypsin inhibitor activity is likely not the significant impediment to protein utilization in guar meal.

Key Words: Guar, Guar meal, Trypsin inhibitor

383 Immobilization of Keratinase-Streptavidin Fusion Protein for Keratinolysis. J.C.H. Shih* and J.-J. Wang, North Carolina State University, Raleigh, NC USA.

Keratinase, produced from *Bacillus licheniformis* PWD-1, is capable of hydrolyzing chicken feather keratin. Immobilized keratinase has many potential applications, including the conversion of ground feathers to soluble protein, peptides and amino acids. A biotechnology for keratinase immobilization has been developed. Fusion genes of keratinase (KER) and streptavidin (STP) were genetically constructed. Transformed *B. subtilis* and *E. coli* expressed and produced the bifunctional fusion protein, KER-STP. Isolation and immobilization were achieved by mixing a biotinylated solid matrix with the *B. subtilis* medium or the *E. coli* lysate. Since the fusion protein was produced intracellularly in the inclusion body of *E. coli*, the extraction and renaturation from the cell lysate were laborious and consequently caused a low yield. *B. subtilis* produced and secreted the fusion protein that can be readily immobilized from the medium. The properties of immobilized keratinase-streptavidin fusion protein were characterized. Heat stability, durability, and pH tolerance were found greatly improved. Kinetic parameters of immobilized keratinase, including V_{max}, K_m, and k_{cat} toward the peptide substrate were also determined and compared with the free enzyme. Hydrolysis of three different substrates, insoluble feather keratin, soluble α-casein and bovine serum albumin (BSA) were carried out and analyzed by HPLC. It is interesting to note that keratinolysis by both immobilized and free keratinase produces a characteristic soluble protein with a molecular weight of 18 kDa. (Patent application pending)

Key Words: feather keratin, keratinase, enzyme immobilization

PSA Physiology

384 Performance and Thermo Tolerance of Broilers as Affected by Genotype and Ambient Temperature. H. A. Al-Batshan* and E. O. Hussein, King Saud University, Riyadh, Saudi Arabia.

This experiment was conducted to evaluate the effects of genotype (GT) and ambient temperature (AT) on subsequent performance and body core temperature (CT) of broiler chicks. A factorial arrangement of two GT (Hubbard and ISA) and two rearing AT (either under 33 C and then AT was reduced to 23 C by wk 4, or under constant AT of 33 C throughout the trial) was used in this study. Diurnal CT was monitored continually (2 min intervals) for 4 days using a biotelemetric system at six weeks of age. Results showed that weight gain and feed intake were significantly increased but feed:gain ratio was significantly decreased for Hubbard chicks compared to those of ISA chicks. High AT significantly reduced weight gain and feed intake. There was significant GT by AT interaction for weight gain, revealing that Hubbard chicks were more affected by high AT. Ambient temperature and GT significantly affected CT. Moreover, core body temperature of ISA chicks was significantly higher at the moderate ambient temperature but was significantly lower at the high ambient temperature than those of Hubbard chicks, which resulted in significant GT by AT interaction. The results of this study indicated that chicks with higher growth potential are more susceptible to heat stress.

Key Words: Broilers genotype, Ambient temperature, Diurnal body temperature

385 Changes in Growth and Function of Chick Small Intestine Epithelium Due to Heat Exposure Conditioning. Zehava Uni*¹, Orit Gal-Garber¹, Assaf Geyra¹, David Sklan¹, and Shlomo Yahav², ¹Faculty of Agriculture, Department of Animal Science, The Hebrew University of Jerusalem, Israel, ²Institute of Animal Sciences, ARO, The Volcani Center, Bet-Dagan, Israel.

The effect of exposure to heat at 3 d of age on small intestine functionality and development was assayed by measuring villus size, proliferating enterocytes, and brush-border membrane enzyme expression and activity. Results showed that thermal conditioning caused an immediate effect characterized by lowered triiodothyron (T3) level, reduced feed intake, and depressed enterocyte proliferation and BBM enzyme activity. A second series of effects, observed 48 h posttreatment, was characterized by elevated T3, increased feed intake, increased enterocyte proliferation, and higher expression and activity of BBM enzymes. The association between ambient temperature, feed intake, growth rate, and plasma T3 levels was reflected in the structure and function of the intestinal tract. The results suggest that thermal conditioning at an early age influences T3 concentrations, which in turn alters the intestinal capacity to proliferate, grow and digest. However, these experiments were not able to separate between the effects due to feed intake from those due to thermal conditioning. These changes modulate the intestinal tract for compensatory growth commencing 48 h postthermal treatment.

Key Words: Heat, Small intestine, Chicks

386 Origin of thermal-load induced adaptations in intestinal hexose absorption: heat stress or reduced food intake? M.A. Mitchell*¹, R.R. Hunter¹, M. Moreto², C. Garriga², M. Mitjans², C. Amat², and J.M. Planas², ¹Roslin Institute, Roslin, Midlothian, UK, ²University of Barcelona, Barcelona, Spain.

Previous studies demonstrated increased expression of SGLT-1 transporters in the brush border membranes of enterocytes from chronically

heat stressed chickens. This adaptation may be attributable to the prolonged heat stress per se and/or to the reduced food intake associated with chronic exposure to elevated thermal loads. The present study attempts to dissociate the effects on intestinal function and structure of heat stress and inanition by means of paired feeding. Groups of 8, four week old, female broiler chickens were exposed to thermoneutral (TN; 20C, 50% Relative Humidity) or heat stress (HS; 30C, 70% R. H.) conditions or TN with paired feeding (PF) for 14 days. Food intake was determined daily. Pair fed birds received the amount of food consumed by the heat stress group on the previous day. Body weights and deep body temperatures were monitored throughout the experimental period. Blood samples were taken for hormone analysis (T4, T3, and glucagon). At the end of exposure birds were killed and jejunal segments removed for tissue morphology and assessment of the abundance of the glucose transporters SGLT-1 (brush border membrane - phloridzin binding) and GLUT-2 (basolateral membrane - cytochalasin B binding) and characterization of the transport kinetics of alpha-methyl-D-glucoside in brush border or basolateral membrane vesicles. HS increased phloridzin binding by 54% ($p < 0.05$) and V_{max} for the hexose transport by 55% ($p < 0.05$) in the brush border preparation with no effect upon K_m for active transport or diffusive uptake (K_d). PF had no effect upon binding or transport kinetics. No influence of either treatment (HS or PF) upon cytochalasin binding or hexose transport kinetics was observed at the basolateral membrane. Plasma T3 was reduced in heat stress but T4 and glucagon were unaffected by the treatments. The adaptations in intestinal absorptive function observed during prolonged exposure to elevated thermal loads result directly from the heat stress and not from reduced food intake. The physiological signals mediating this response may include alterations in endocrine and paracrine activity.

Key Words: intestinal absorption, heat stress, chicken

387 Assessment of densitometry to measure bone mineral content and density in live birds as a tool for monitoring osteoporosis in laying hens. M.A. Schreiweis*¹, J.I. Orban², M.C. Ledur³, and P.Y. Hester¹, ¹Purdue University, W. Lafayette, IN, ²Southern University, Shreveport, LA, ³Embrapa Swine and Poultry Research Center, Concordia, SC, Brazil.

Osteoporosis, or loss of structural bone, may be induced by a high rate of lay, demand for calcium during eggshell formation, and limited exercise of birds in caged system. The objective of the current study was to determine the accuracy of bone densitometry as a non-invasive tool for monitoring bone integrity in an egg-laying strain of birds. Bone mineral content (BMC) and bone mineral density (BMD) of the right leg (tibia and fibula) and wing (humerus) bones were determined in 10 adult White Leghorn hens, 75 wk of age, using a Norland pDexa X-ray bone densitometer (Model # 476D014). The scans of respective bones were conducted in live, unanesthetized birds. Following live scans, birds were euthanized, and the humerus and tibia/fibula bones were excised and scanned in the same orientation as the previous live bird scan. The medullary tibia from live bone scans had significantly greater BMD ($0.249 \pm 0.022 \text{ g/cm}^2$) than the pneumatic humerus ($0.166 \pm 0.025 \text{ g/cm}^2$, $P < 0.0001$). The BMD and BMC of excised bones were strongly correlated with live scans ($r = 0.97$ and 0.99 , respectively). Variation in BMD among live scans of the 10 hens occurred as indicated by CV of 9% for the tibia and 15% for the humerus. In a subsequent experiment, live scans of 35 pedigree Hy-Line White Leghorn pullets, 15 wk of age, showed CV among birds of 7% for BMD in both the humerus and tibia. The BMD for tibia and humerus were 0.132 ± 0.010 and $0.110 \pm 0.008 \text{ g/cm}^2$, respectively ($P < 0.0001$). In Hy-Line birds 17 wk of age, the BMD and BMC of 10 excised bones did not differ from respective bones of live scans performed in situ ($r = 0.91$ and 0.99 , respectively). These preliminary data suggest that variation derived from densitometric scans of live birds may serve as a non-invasive tool for genetically selecting against osteoporosis.

Key Words: Bone density, Laying hen, Osteoporosis

388 Matrix metalloproteinases in turkey bile. N. C. Rath*, G. R. Huff, W. E. Huff, and J. M. Balog, PPSR/ARS/USDA, Fayetteville, AR.

Matrix-metalloproteinases (MMPs), gelatinases, interstitial collagenases, stromelysins, and membrane-type MMPs, are endopeptidases

which breakdown extracellular matrix (ECM) components such as collagens and proteoglycans. The MMPs are involved in a variety of physiological functions such as tissue remodeling, angiogenesis, wound healing, and immune regulation. We found that turkey bile contains substantial gelatinase, collagenase, and stromelysin-like activities using gelatin, collagen, and casein zymography, and ³H labeled collagen degradation assays. The intact bile showed at least five major gelatinolytic bands corresponding to approximate MW 64 kDa, 60 kDa, 46 kDa, 40 kDa, and 36 kDa. Organomercurial compounds, p-aminophenylmercuric acetate and thimerosal, which facilitate transformation of proMMP to MMP, caused conversion of the 64 kDa band to the 60 kDa and the 46 kDa to the 40 kDa forms, respectively. The 64 kDa and the 60 kDa bands showed collagenolytic activities whereas the caseinolytic (stromelysin) activities appeared as diffuse bands corresponding to MW of approximately 60 kDa, 40 kDa, and 36 kDa. The bile enzymes showed both a time and a concentration dependent increase in the degradation of ³H-collagen which could be inhibited by EDTA, phenanthroline, and GM 6001 (the MMP inhibitors) but not by serine and cysteine protease inhibitors like phenylmethylsulfonyl fluoride and leupeptin. The 60 kDa and the 40 kDa gelatinase showed affinity adsorption to a gelatin-agarose matrix. The physiological functions of biliary MMPs are not clear. However, in most carnivorous and omnivorous birds there is a need to digest animal tissue proteins consisting of fair amounts of collagens and other ECM proteins in their native forms, therefore, MMPs may be involved in the digestion and denaturation of these proteins which may otherwise be resistant to conventional proteinases such as pepsin, trypsin, and chymotrypsin. These data provide evidence which suggests that biliary MMPs may be involved in the digestive process of birds.

Key Words: Turkey, Bile, Matrix metalloproteinases

389 Development of the indicator amino acid oxidation technique for measuring amino acid requirements in chickens. H. Y. Tabiri*, R. O. Ball, R. Bertolo, and D. R. Korver, University Of Alberta, Edmonton, AB, Canada.

The indicator amino acid oxidation (IAAO) technique is being adapted for use in chickens as a rapid and sensitive method to determine amino acid (AA) requirements. During IAAO, Phe oxidation decreases, inversely to the change in protein synthesis, as limiting AA intake increases from deficient to adequate. In IAAO, the plateau in breath ¹⁴CO₂ during continuous infusion of labeled phenylalanine (Phe) is used to measure Phe oxidation. Plateau is reached when the ¹⁴CO₂ recovered from breath becomes constant as verified by linear regression. Bicarbonate retention factor (BRF) must be determined to correct for ¹⁴CO₂ that is not recovered in the breath. Metabolic chambers were constructed and calibrated to ensure 100% recovery of ¹⁴CO₂ liberated from NaH¹⁴CO₃. A surgical procedure was established to ensure long-term patency of jugular catheters. Male broiler breeders were surgically implanted with venous catheters, placed in the chambers and infused with NaH¹⁴CO₃. Breath ¹⁴CO₂ was recovered; BRF was 13.12% of infused dose. For the determination of Phe oxidation a bolus of ¹⁴C-Phe ranging from 4.5 to 7 $\mu\text{Ci/kg}$ was used to determine the correct priming dose for the Phe pool. A constant infusion dose was maintained at $3.5 \mu\text{Ci/kg}^{-1}$ for ratios of continuous infusion to priming doses of 1.29, 1.57 and 2.00. At a ratio of 1.57, breath ¹⁴CO₂ attained a plateau between 30 and 60 min after initiation of continuous infusion and remained constant for the next 3 hours. Phe oxidation at plateau was found to be 4.66% (uncorrected for BRF) and 5.27 % (corrected for BRF) of the infused dose. The % Phe dose oxidized is sufficient to be sensitive to changes in AA intake, making it suitable for the determination of AA requirements in chickens using the IAAO technique. This is the first study to our knowledge to determine BRF and Phe oxidation, from primed, constant infusion rate methodology, in chickens. The methods established in the present study will be used to estimate AA requirements in poultry.

Key Words: Indicator Amino Acid Oxidation Technique, Amino Acid Requirements, Bicarbonate Retention Factor

390 Dietary protein regulates in vitro lipogenesis and lipogenic gene expression in broilers. R. W. Rosebrough*, S. M. Poch, B. A. Russell, and M. P. Richards, ARS, Beltsville, MD.

The purpose of this experiment was to determine the possible relationship between certain indices of lipid metabolism and gene expression in chickens fed graded levels of dietary crude protein. Male, broiler chickens growing from 7 to 28 days of age were fed diets containing 12, 21 or

30% protein ad libitum. In addition, another group of birds was feed on a regimen consisting of a daily change in the dietary protein level (12 or 30%). This latter group was further subdivided such that one-half of the birds received each level of protein on a particular day. Birds were sampled from 28 to 30 days of age. Measurements taken included *in vitro* lipogenesis (IVL), hepatic enzyme activities and gene expression of these enzymes and thyroid hormones. *In vitro* lipogenesis was determined by incubating liver explants for 2 h at 37 C in Hanks salts containing 25 mM HEPES and 10 mM [2-¹⁴C]acetate. *In vitro* lipogenesis and ME activity were inversely related ($P < 0.01$) to dietary crude protein levels (12 to 30%) and by acute changes from 12 to 30%. In contrast, ME, FAS and AcCBX message expressions were constant over a dietary protein range of 12 to 21%, but were decreased ($P < 0.01$) by a 30% protein diet (acute or chronic feeding). Increasing dietary crude protein increased ($P < 0.01$) the activities of both AAT and ICD. Results of the present study demonstrate a continued role for protein in the regulation of metabolism in the broiler chicken. It should be pointed out, however, that metabolic regulation at the gene level only occurs with very high levels of dietary protein.

Key Words: Lipogenesis, Gene expression, Metabolism

391 Metformin decreases feed intake and induces hypoglycemia in broiler chicken. C.M. Ashwell^{*1} and J.P. McMurtry¹, ¹Growth Biology Laboratory, USDA-ARS, Beltsville, MD.

The bi-guanide metformin is used to treat non-insulin dependent diabetes in obese patients. In addition to having anti hyperglycemic effects, metformin is also anorectic and reduces body weight. These studies were performed to determine if metformin possesses similar properties in chickens. Metformin HCL was administered to 14-day old broiler chickens at either 300 or 600 mg/kg/day in the drinking water for 10 days while monitoring body weight and feed intake. No changes in water intake were observed, while feed intake and daily gains were only significantly reduced by the 600 mg/kg dose. After oral administration of a single dose of 300 mg/kg metformin HCL, feed intake was significantly reduced ($p = 0.011$) by 4 hours and remained suppressed for greater than 24 hours relative to controls. Plasma hormones and metabolites (glucose, lactate, insulin, glucagon, IGF-I, IGF-II, uric acid, NEFA, triglycerides, and cholesterol) were monitored at 1, 2, 3, 6, and 24 hours post treatment. Significant and acute decreases in blood glucose, insulin, and triglycerides were observed at 3 hours post treatment as compared to controls. Opposing acute increases in glucagon, IGF-II, and NEFA levels were also observed at 3 hours, followed by an increase in uric acid 6 hours post treatment. These observations suggest that metformin induces metabolic changes in birds, similar to that observed in mammals. Metformin may be useful in glucose metabolism studies by inducing hypoglycemia, a condition rarely observed in birds

Key Words: Feed Intake , Hypoglycemia, Broiler

392 *In ovo* and post-hatch administration of peptide YY (PYY) does not affect growth and feed conversion in Cobb X Cobb broiler chickens. B.A. Coles, J. Croom*, J. Brake, and L.R. Daniel, North Carolina State University, Raleigh, NC USA.

In ovo PYY administration at e18 increased 7 d but not 21 d or 42 d BW and adjusted feed conversion ratios (AFCR) in Ross male x Cobb female broilers (Coles et al., 1999). The present study was conducted to investigate whether post-hatch administration of PYY prolonged the positive effects of *in ovo* PYY administration on growth and feed conversion. On e18, Cobb x Cobb eggs were randomly divided into two treatment groups and 100ml of either 1.025% saline (control) or 1.025% saline plus 600 µg PYY/kg egg weight was injected into the air space. At hatch, birds (n = 1280) were sexed, wing-banded and randomly placed in 64 pens within a grower house (16 pens/house quarter, 4 reps/quarter, 20 birds/pen). Water and feed was offered *ad libitum*. Birds and feed were weighed on a pen basis at placement and 1, 2, 3, and 6 wk. At 1 wk, birds were weighed and administered either saline (control) or saline plus 600 µg PYY/kg BW s.c. No further injections were given beyond week 1. Growth data were statistically analyzed with treatment, sex and pen position (house block quadrant) as main effects using the GLM procedure of PC-SAS. At the completion of the study, 8 males per treatment were euthanized and intestinal length, weight and jejunal glucose uptake measured. There was a significant PYY x sex interaction in BW at hatch. Control females were heavier than females from PYY treated

eggs at hatch ($p = .04$, 39.65 g vs 39.05 g, respectively). This difference was not present at 1, 2, 3, and 6 wk. Both total intestinal length and intestinal length adjusted for BW were greater in PYY treated males at 6 wk as compared to controls ($p = .004$, .446 vs .380 per g BW, respectively). These data support previous observations of PYY's hypertrophic effect on the intestines. They do not confirm earlier reports of PYY's ability to enhance intestinal glucose absorption or post-hatch growth in poultry. These data suggest major genotypic effects on PYY's biological activity in broilers.

Key Words: Peptide YY, Broilers, Growth

393 Mitochondrial Function and Feed Efficiency in Broilers. W. Bottje^{*1}, Z. Tang², M. Iqbal¹, D. Cawthon¹, T. Wing³, and M. Cooper³, ¹Dept. of Poultry Science, University of Arkansas, Fayetteville, AR 72701, ²Dept. of Veterinary Pathophysiology, South China Agricultural University, Guangzhou 510642, PRC, ³Cobb-Vantress Inc., Siloam Springs AR 72761..

The objective of this study was to determine relationships of mitochondrial function with feed efficiency (FE) in broiler males. Between 5 and 6 wk, FE was determined in 100 broiler breeder males. Birds with high (0.83 0.01, n = 7) and low (0.64 0.01, n = 7) FE were selected for mitochondrial studies. As feed intake did not differ ($P > 0.50$) between groups ($P > 0.50$), differences in FE were due to greater body weight gain ($P < 0.05$) in the high FE broilers. Mitochondria were isolated from individual birds by differential centrifugation. The respiratory control ratio (RCR, an index of respiratory chain coupling) was higher in breast and leg muscle mitochondria in the high FE group; due primarily to a lower state 4 (resting) respiration. Additionally, breast muscle mitochondrial hydrogen peroxide generation (an index of electron leak) was; a) higher in low FE breast muscle mitochondria, and b) magnified in low FE mitochondria by inhibition of electron transport by rotenone and antimycin A (at Complex I and III, respectively) indicating sites of electron leak from the respiratory chain. Complex I and II activities were higher in high FE than in low FE mitochondria. High FE mitochondria exhibited a much smaller ratio of Complex I to Complex II activities than did low FE mitochondria. Positive correlations were observed between feed efficiency and RCR and Complex activities. The results indicate that low FE was associated with a) lower RCR, b) higher electron leakage, and c) lower activities of respiratory chain Complex I and II activities compared to high FE mitochondria. The findings provide insight into cellular mechanisms associated with feed efficiency in broilers.

Key Words: Mitochondria, Feed Efficiency, Broilers

394 Cardiac energy metabolism slow and fast growing chickens. A.A. Olkowski* and H.L. Classen, University of Saskatchewan, Saskatoon, SK, Canada.

The present study compares the activity of cytosolic enzymes involved in energy synthesis, Creatine Kinase (CK) and Lactate Dehydrogenase (LDH), in left (LV) and right (RV) ventricular myocardium of fast growing broilers (susceptible to heart failure), and slow growing leghorns (resistant to heart disease). Within the category of broilers, comparisons are made between feed restricted, slow growing birds (low incidence of heart failure and ascites), fast growing birds fed ad libitum (high incidence of heart failure and ascites), and broilers with ascites. Overall, the activity profile of CK was lower ($P < 0.01$) in broilers in comparison to leghorns in both LV and RV, but the differences in the activity of the CK system among slow growing, fast growing, and ascitic broilers were only marginal. Total LDH activity was lower ($P < 0.01$) in slow growing broilers in comparison to leghorns. The total activity of LDH was 21, 15, and 9% higher in LV than in RV in leghorns, slow growing broilers, and fast growing broilers respectively, but not in ascitic broilers. There were no differences in total LDH activity in RV in fast growing and ascitic chickens in comparison to leghorns, but relative to leghorns the total LDH activity in LV was approximately 28% lower in slow growing broilers, and 20% lower in fast growing and ascitic broilers (both $P < 0.01$). This indicates that the metabolic demand for catalytic activity of LDH is higher in LV than in RV, and that broilers, in particular, may have insufficiency of LDH activity in LV. Considering that CK and LDH activities are generally lower in broilers in comparison to leghorns, it appears that the energy metabolism capacity may be insufficient in broilers. Inadequate activity of these enzymes may limit the ability of the cardiac muscle to increase its contractile performance during rapid

growth or in response to cold stress. From the present results it appears that, in comparison to leghorns (resistant to heart failure), fast growing broilers (susceptible to heart failure) in general have lower cardiac energy reserve.

Key Words: broiler, energy metabolism, heart failure and ascites

395 Investigation of Proton Conductance in Liver Mitochondria of Broilers with Pulmonary Hypertension Syndrome (PHS). D. Cawthon*, M. Iqbal, J. Brand, and W. Bottje, *Department of Poultry Science, Univ. of Arkansas, Fayetteville AR 72701.*

We have observed mitochondrial dysfunction associated with PHS in broilers that includes increased oxygen radical production. Proton leak or conductance (the futile cycling of protons across the inner mitochondrial membrane) can account for at least 20% of mitochondrial O₂ consumption. The objective of this study was to determine if proton conductance differs in Control and PHS liver mitochondria. Liver mitochondria were isolated from broilers with PHS and from healthy Controls. PHS mitochondria had a lower respiratory control ratio than did Controls. Membrane potential and O₂ consumption were determined simultaneously by monitoring the distribution of the lipophilic cation (triphenylmethylphosphonium [TPMP]) with an ion-sensitive electrode and a Clark electrode, respectively (see Brand, 1995. Ch. 3 Bioenergetics IRL Press, Oxford). Mitochondria were treated with nigericin to dissipate the H⁺ gradient to enable membrane potential to be determined without concomitant changes in H⁺ concentration across the membrane. Proton conductance was assessed by following changes in TPMP⁺ as state 4 respiration was slowed with sequential additions of malonate. The results indicated that at any particular high membrane potential, the PHS mitochondria respired more slowly than Controls. This is the classic demonstration of a lower proton conductance in PHS mitochondria. The lower proton conductance may account for the increased oxygen radical production we have previously observed in PHS mitochondria. These findings help define the nature of mitochondrial dysfunction in broilers with PHS. (Supported by USDA-NRI #99-02123 to W. Bottje.)

Key Words: Pulmonary Hypertension Syndrome, Liver Mitochondria, Proton Conductance

396 Tissue and Mitochondrial Antioxidant Enzyme Activities in Broilers with Pulmonary Hypertension Syndrome (PHS). M. Iqbal*, D. Cawthon, R. Wideman, Jr., and W. Bottje, *Department of Poultry Science, Univ. of Arkansas, Fayetteville, AR 72701.*

Oxidative stress plays a role in the etiology of PHS in broilers. The objectives of this study were to determine if antioxidant enzyme activities a) are altered by PHS and/or high dietary vitamin E (VE), and b) differ in broilers genetically selected (S) or not selected (NS) for PHS resistance. In these studies, broilers were raised in cold temperatures to induce PHS. In Exp. 1, broilers were fed diets with 15 and 100 IU α -tocopherol (VE) per kg. Enzyme activities were determined spectrophotometrically using established procedures that were adapted for microtiter plate analyses. In Exp. 1, PHS lung mitochondria exhibited oxidative stress (lower α -tocopherol, reduced glutathione [GSH] and higher oxidized [GSSG] to reduced GSH ratio) that was associated with higher GSH peroxidase (GSHPx) and lower GSH reductase (GSHRed) activities compared to Controls. Liver γ -glutamyl cysteine synthetase (gGCS), the rate limiting enzyme in GSH synthesis was unaffected by

PHS or high VE. In liver, high dietary VE lowered GSHPx but had no effect on GSHRed or gGCS activities. In Exp. 2, GSHPx activity was higher and GSHRed lower in lung mitochondria obtained from NS compared to S broilers. The lower GSHRed activity corresponded to a higher GSSG/GSH ratio. Whereas there was no differences in liver GSHPx and GSHRed activities, liver gGCS activity was lower in livers obtained from NS compared to S broilers. The results indicate that activities of antioxidant enzymes are altered by PHS, presumably in response to the oxidative stress present in these birds. Modulation of antioxidant activities by high VE was observed in liver tissue. Higher gGCS in the liver birds genetically resistant to PHS could be important in overall antioxidant status of these birds. (Supported by USDA-NRI #99-02123 to W. Bottje.)

Key Words: Pulmonary Hypertension Syndrome, Antioxidant Enzymes, Broilers

397 Effects of dietary sodium chloride, sodium sesquicarbonate, or ammonium chloride, in various combinations and levels, on ascites susceptibility of young broiler chickens in a cool environment at simulated high altitude (17% oxygen). R. G. Teeter*¹, J. H. Swartzlander¹, A. Beker¹, D. M. Hooge², and K. R. Cummings, ¹Oklahoma State University, Stillwater, OK, ²Hooge Consulting Service, Inc., Eagle Mountain, UT, ³Church & Dwight Company, Inc., Princeton, NJ.

Day old, vaccinated Cobb 500 chicks were evaluated in two metabolic chamber studies, 240 chicks per trial (24 chambers of 10 birds each), to 21 days old under moderate cool stress and 17% oxygen atmosphere (nitrogen administration). Ten practical corn-soy-meal blend diets were formulated to contain various levels of sodium chloride (NaCl) or sodium sesquicarbonate (SS; 30.4% Na) singly, or in combination, or ammonium chloride (AC; 66% Cl) and SS in place of NaCl. The SS has equimolar Na bicarbonate and Na carbonate. Analyzed Na levels were 0.19, 0.28, and 0.37% in combinations with Cl levels of 0.11, 0.25, and 0.39% (from previous regular pen trial, using same basal diet, in which 0.23% NaCl + 0.3% SS gave best broiler results with ionophore, coccidial challenge, and built-up litter; see Hooge *et al.*, 2001, IPF abstract 14, Atlanta). Dietary electrolyte balances, Na+K-Cl in mEq/100 g, ranged from 20.8 to 36.5. Significance was at P<0.05 using a completely randomized design. Body weights overall were below industry norms due to oxygen deficiency. The SS treatments without NaCl appeared deficient in Cl; for example, the 0.3% SS diet with 0.19% Na and 0.11% Cl was lower in body weight at wk 1 and 2 than all or most other treatments, but adapted somewhat by wk 3. Heaviest 3 wk body weight was with 0.46% NaCl and lightest was with 0.23% NaCl + 0.3% SS. No differences in feed conversion ratio were detected. Right ventricle weight and ascites heart index (right ventricle/total heart) were not affected, but ascites score (0=least to 3=most severe; P=0.054) at wk 1 was highest for 0.3% SS + 0.42% AC, with 0.23% NaCl intermediate, and 0.3% SS lowest. The 0.23% NaCl control had lowest oxygen consumption, heat production, and carbon dioxide exhaled, but third highest 3 wk weight. Hematocrit was negatively correlated (r²=-0.53) with oxygen consumption or heat production. This confirmed a relationship previously found between lower oxygen consumption, lower heat production, higher hematocrit, and higher ascites score. Under simulated high altitude and moderate cool stress, young broilers had best 3 wk weight (541.7 g) and worst ascites score (0.74) with 0.28% Na and 0.39% Cl from 0.46% NaCl, which could be moderated to good weight (488.7 g) and ascites score (0.52) with 0.37% Na and 0.39% Cl from 0.46% NaCl + 0.3% SS.

Key Words: Ascites, Salt, Sodium sesquicarbonate

Nitrogen, Phosphorus, and Sulfur Interfaces Between Beef Cattle Production and the Environment

398 Federal environmental policy directions for animal agriculture. J.S. Jonker*, *AAAS Environmental Fellow - US EPA, Washington, DC USA.*

The animal agriculture industry has undergone dramatic changes in the past 20 years. The trend toward fewer but larger operations, coupled with greater emphasis on more intensive production methods and specialization, has concentrated more animal manure within some geographic areas. This increase in geographic concentration has led to an increasing concern over environmental impacts of animal agriculture. According to the 1998 *National Water Quality Inventory* which re-

ported on assessments for 32 percent of the U.S. waters, 27,751 river and stream miles and 99,936 lake acres were impacted by animal feeding operations. A recent USDA analysis of 1997 county-level manure production relative to crop uptake in the United States estimated 73 counties had excess manure N and 160 counties had excess manure P. The number of counties with excess manure nutrients has significantly increased since 1982. Some manure could be exported to cropland in other nearby counties, but manure bulk will limit the distance manure can be transported economically. For many of these counties with excess manure nutrients, alternative uses for excess manure will need to be ex-

plored. The role of Federal regulation is to meet an endpoint goal, such as drinking water quality standards. Current and proposed Federal regulations do not dictate specific technologies or alternative uses for excess manure production. However, to meet endpoint goals for water quality, Federal regulations compel animal agriculture to find solutions to excess manure. Because regulatory approaches only impact 5 to 10% of all animal farms, voluntary and incentive based programs are also a vital part of the Federal environmental policy for animal agriculture.

Key Words: Environment, Federal Government, Water Quality

399 Phosphorus recommendations for beef cattle and factors related to their development and use. J.F. KARN*¹, ¹USDA-ARS, Northern Great Plains Research Lab, Mandan, ND, USA.

Current phosphorus recommendations for beef cattle will be discussed and research supporting these recommendations will be explored. Although recommendations have generally decreased in recent years, they must still contain some margin of safety, due to the many variables which affect beef cattle phosphorus requirements, especially under grazing conditions. There are many factors which make it very difficult to assess the true supplemental phosphorus needs of grazing cattle. Soil phosphorus levels are a reflection of soil parent materials and vary widely in the United States and around the world. Forage phosphorus levels reflect not only soil phosphorus levels and availability, but also forage species and stage of maturity. Animal affects include rumen microbial requirements; variation in absorption coefficients; interaction of phosphorus with nitrogen and other minerals; bioavailability differences among supplemental phosphorus sources; the availability of body stores of phosphorus and breed differences. Responses of grazing cattle to phosphorus supplementation have been inconsistent among and within geographical locations. Forage tissue phosphorus concentrations, as well as phosphorus concentrations in many animal tissues, have been considered as status indicators; but none have been consistently reliable. The impact of the above factors on phosphorus requirements, and phosphorus status indicators, as well as responses to phosphorus supplementation will be discussed. Additional knowledge is needed on many factors affecting phosphorus recommendations, and their practical application, to minimize production costs and to reduce phosphorus levels in effluent from pastures and feedlots which may affect the ecosystem of adjacent streams, ponds and lakes.

Key Words: Beef cattle, Phosphorus requirements, Supplementation

400 Effects of manipulating protein and phosphorus nutrition of feedlot cattle on nutrient management and the environment. T. J. Klopfenstein* and G. E. Erickson, University of Nebraska, Lincoln, NE.

Feedlot nutrition will play a role in meeting challenges such as nutrient management. Nitrogen and phosphorus are two nutrients that are currently studied in this context. One nutritional method is formulating diets to not exceed requirements for nitrogen and phosphorus. Requirements are different for calves versus yearlings. The requirements also change during the finishing period. Phosphorus requirements have not been extensively studied for feedlot cattle between 270 and 600 kg. Therefore, P requirement studies were conducted to determine the P requirement of calves (265 kg) and yearlings (385 kg). The requirement was not detected with P levels as low as .14 (yearlings) and .16% (calves) of diet DM based on performance and bone ash. Compared

to NRC-predicted P requirements, P intakes ranged from 76 to 190% (calves) and 71 to 162% (yearlings). In separate nutrient balance experiments, decreasing dietary P to NRC-predicted requirements (.22 to .28%) did not influence gain but decreased P input by 33 to 45% and excretion by 40 to 50% when compared to industry average (.35% P). The metabolizable protein (MP) system was recently adopted and may allow more accurate diet formulation for protein, thereby decreasing N excretion. Compared to industry average (13.5% CP) and formulation with the CP system, using the NRC model and phase-feeding to not exceed MP requirements over the feeding period decreased N inputs by 10 to 20% for calves and yearlings without affecting ADG. Decreasing N inputs led to a concomitant decrease in N excretion (12-21%) and volatilization (15 to 33%) in open-dirt feedlot pens. Nitrogen losses are variable with time of year, with averages of 60 to 70% of excreted N lost during the summer months and 40% lost from November to May feeding periods. Protein requirements are continually being refined as more research data are collected. However, formulation to meet and not exceed protein requirements and removal of P supplements are important nutritional management options to help feedlots become more environmentally sustainable.

Key Words: Nitrogen, Phosphorus, Cattle feedlots

401 Livestock odor abatement with plant-derived oils and urease inhibitors. Vince Varel*, USDA/ARS, U.S. Meat Animal Research Center, Clay Center, NE.

Confined animal feeding operations are under environmental scrutiny for production of large quantities of waste in a small area. The waste can result in odor, global warming gases and the transfer of nutrients and pathogens to water and food sources. An incomplete anaerobic degradation of the carbohydrate, protein, and lipid components in waste is the primary cause of odor emissions. This incomplete degradation results in the formation of short-chain volatile fatty acids (VFA), amines and other nitrogenous compounds, and sulfur-containing compounds. Our objectives are to provide simple, cost effective, and environmentally sound solutions to control odor and pathogens in livestock waste, with nutrient management a top priority. A urease inhibitor, N-(n-butyl) thiophosphoric triamide, was used to reduce urea hydrolysis in beef cattle feedlot pens, conserve nitrogen, and inhibit ammonia emissions which contribute to odor. Laboratory studies with antimicrobial plant-derived oils, thymol and carvacrol, at 2 g kg⁻¹ of feedlot waste completely inhibited the production of VFA in flasks over 42 days. Fecal coliforms were reduced from 4.6 x 10⁶ to 2.0 x 10³ cells ml⁻¹ 2 days after treatment, and were nondetectable within 4 days. Total anaerobic bacteria were reduced from 8.4 x 10¹⁰ to 1.5 x 10⁷ cells per ml after 2 days and continued to be suppressed to that level after 28 days. These plant oils are not degraded under anaerobic conditions. However, our feedlot studies and the literature indicate these oils are degraded under aerobic conditions. This suggests that these generally recognized as safe (GRAS) chemicals, which are routinely used as preservatives in food and personal care products, should not accumulate in soils to which this waste is applied. It is concluded that chemical additives can be added to animal waste to prevent degradation, which in turn controls odor emissions, reduces pathogens, and conserves nutrients until the waste can be recycled as fertilizer. The economics and environmental effects of using thymol and carvacrol in livestock production facilities need to be determined.

Key Words: Livestock Waste, Odor, Essential Oils

Companion Animal Biology as a Focal Point in the Animal Sciences

402 Issues surrounding the teaching of companion animal biology in an animal science department. Neal R. Merchen* and Linda P. Case, University of Illinois, Urbana, IL.

Animal Sciences departments are increasingly faced with decisions about inclusion of courses and training programs related to companion animals in their curricula. Companion animals are economically important through sales of pet food and other accessories and payment for veterinary services. The pet food manufacturing industry uses large quantities of agricultural commodities. Demographics of students have changed such that the majority of students in many Animal Sciences departments are now women, come from urban backgrounds, and tar-

get advanced study (veterinary medicine, other professional curricula, graduate study) as goals following completion of their undergraduate programs. These characteristics often reflect students whose primary animal-related experiences and interests are with companion animals. Thus, Animal Sciences departments need to consider curricula additions that include more training in companion animal biology. A curriculum in companion animal biology has been developed at the University of Illinois. Courses are taught in Companion Animal Biology (general survey of all disciplines related to companion animals) and Human-Companion Animal Interactions. A course in Companion Animal Nutrition has been developed and is offered to junior-senior and graduate students. In ad-

dition to traditional course work, opportunities have been established for student internships with pet food companies, animal shelters, and dog training centers. An annual field trip offers students direct exposure to career opportunities in companion animal management, training, and nutrition. Animal Sciences students that have training with companion animals have enjoyed enhanced experiences in veterinary medicine and opportunities for careers in occupations related to companion animals.

403 Research in companion animal biology: Topics of importance, current controversies, and opportunities. Gail Czarnecki-Maulden¹ and John Bauer*², ¹*Friskies*, ²*Texas A&M University*.

Both fundamental and applied research initiatives in companion animal biology are available in university environments. Where Colleges of Agriculture and Veterinary Medicine co-exist on a single campus, interdisciplinary collaborations using clinical case materials provide unique opportunities for creative investigation. In the absence of such combined resources, opportunities for basic research also exist. Initiatives for companion animal research are generally more similar to those of human health rather than animal production and areas ranging from digestive physiology to genomics are of interest to several funding agency sources. Examples of funding sources, key meetings for interaction and development of mutual interests, and examples of several existing programs in companion animal biology focusing on nutrition will be described. Opportunities for developing key programs in other aspects of companion animal health are also ripe for exploration. As for industry, there is a considerable basic research effort in companion animal nutrition. This research is aimed at providing a point of difference vs competitor products and is often targeting visible differences rather than the more traditional indicators of nutritional adequacy used in the livestock industry. The non-invasive policies of most pet food companies also provide unique challenges to the researcher within industry. Career opportunities for animal scientists in the pet food industry and current research topics will be discussed.

404 Outreach efforts in companion animal science: Issues, controversies, and opportunities. Steven Zawistowski¹ and Tim Phillips*², ¹*American Society for Prevention of Cruelty to Animals*, ²*Watt Publishing Co.*

Well over half of all American homes have a companion animal, and the purchase and care of these animals is a multi-billion dollar business. In addition to direct expenditures associated with companion animals are the additional monies associated with enhanced health care when animals are employed as therapeutic partners or, conversely, the billion dollars in insurance claims made each year due to dog bites. Surveys of pet owners consistently show that a majority celebrate their pet's birthday and buy gifts at holiday time. At the same time, millions of abandoned animals die in animal shelters each year. These contrasts are linked by a common theme. There is a lack of consistent high quality information

on pet acquisition and care, and this is partly due to limited opportunities for education and training of specialists and professionals to participate in the field. Pet care businesses, animal shelters, and extension efforts all require individuals with a background in animal sciences that incorporate the most up-to-date information on nutrition, behavior and management skills. Opportunities in companion animal biology include positions at biomedical facilities, petfood companies, petfood industry suppliers, diagnostic laboratories, colleges, humane societies, animal control facilities, veterinary practices, drug companies, and the military. According to the American Veterinary Medical Association, the areas of greatest potential are molecular biology, toxicology, laboratory animal medicine, immunology, diagnostic pathology, environmental medicine and other specialties, including nutrition. Evidence of a strong interest in companion animal education can be found in the growth of Petfood Forum, an international symposium for those involved with the petfood industry. Since 1993, attendance has grown from 319 to over 1,000 people.

405 Role of animal science departments and the American Society of Animal Science (ASAS) in fostering companion animal programs. Maynard Hogberg*¹ and Ellen Bergfeld², ¹*Michigan State University*, ²*American Society of Animal Science*.

Companion animal programs appear to be on the increase in animal sciences departments in the United States. The changing structure of animal agriculture has caused the traditional student pipeline from livestock farms to diminish greatly. As a result, departments are struggling to maintain enrollments and retain resources. It is critical that departments study and understand the implications that companion animal programs can have upon the following: departmental mission, student enrollment and student credit hours generated, type of students enrolled, departmental resources, fundamental research programs, relationship with Colleges of Veterinary Medicine and placement opportunities in the companion animal field. Companion animal programs can have a very positive impact on traditional animal science programs if properly planned and administered. As for ASAS, the companion animal area represents a vast opportunity for increasing membership and providing information to the public at large regarding animal science. The ASAS mission is "to discover, disseminate and apply knowledge for the sustainable use of animals for food and other human needs". Companionship of animals is a perceived need by many in today's society. ASAS membership and clientele demographics continue to change. A look forward suggests greater numbers of members with non-food animal interests and a shift from "food animal" to "animal". ASAS needs to recognize and embrace companion animal research and education as a legitimate component of animal science; foster greater collaboration with AVMA, veterinary medical colleges, and other related companion animal interest groups; develop educational materials for K-12 (K-life) distribution; and plan symposia, workshops, and other educational events that will be valued by both our members and the general public.

Future U.S. Swine Industry

406 The U. S. Swine Industry: Where we are & how we got here. R. L. Plain*, *University of Missouri-Columbia*.

Hog prices fell below the cost of production in November of 1997 and stayed there until February 2000. During this unprecedented period, hog producers lost over \$4 billion. Producers responded to the record red ink as they always have, by reducing hog numbers. Only this time, the liquidation was less than history would have predicted. Structural change has given us a hog industry that is geared for growth and reluctant to downsize itself. Ten trends are shaping the U.S. swine industry: 1. Improved herd performance: Over the last 20 years, the nation's hog farms have produced 3% more pork per breeding animal per year. 2. Fewer & Bigger Hog Farms: The number of U.S. hog farms has declined from over 1 million farms in 1967 to only 85,760 in 2000 with 235 operations owning 52% of the hogs. 3. Specialization: In 1920, 75% of all U.S. farms raised hogs. Today, only 5% have hogs. 4. Fewer & Bigger Packing Plants: Just as hog farms have become fewer and bigger, so have hog slaughter plants. The concentration ratio for the top four firms increased from 33% in 1980 to 56.2% in 1999. 5. Geographic Shift in Production: Unlike the past, recent growth in production has been in grain deficit regions. 6. Integration of Production & Packing: Four major packers are on the list of the nation's 6 largest hog producers.

Packers currently own 25% of the nation's hogs. 7. Integration of Packing & Processing: Packers are rapidly expanding their ability to further process and brand their pork. 8. Contracting: Over 32% of hogs were finished under production contracts in 1999. In January 2001, only 17% of hogs were purchased on the spot market. 9. Globalization: World trade in pork is increasing by about 8% per year. Last year, we exported over 6% of U.S. pork production. 10. Not In My Back Yard: There is growing community aversion to hog production and packing.

Key Words: Swine, Economics

407 The view from an integrated system. J.D. Lehenbauer*, *America's Best Pork*[®], *Farmland Foods, Inc., Kansas City, MO*.

Three key factors will be the primary drivers of future change in the pork industry: 1) customer demands for specific pork quality characteristics; 2) reduction of food safety risks; and 3) the ability to coordinate and trace the identity of market hog deliveries that satisfy pork quality and food safety requirements. To address these changing dynamics in the pork industry, Farmland Foods developed America's Best Pork[®]

("ABP"), a vertically coordinated pork production system. ABP consists of three primary components: 1) proprietary Triumph genetics; 2) a USDA-approved process verification program; and 3) market hog purchase agreements. Within two years, producer participation in ABP has grown to more than 230,000 sows, which represents more than 55% of Farmland Foods' total processing capacity. From an industry per-

spective, independent producers will have less and less control in the future over major production decisions such as genetics, nutrition, and production practices as pork processors compete to satisfy customers' demands for quality, food safety, and price.

Key Words: Integrated system, Pork, Process verification

Genetics of Carcass Merit and Meat Quality

408 Genetic prediction for time to finish end points in beef cattle. B. L. Golden*¹, ¹Colorado State University.

In national beef cattle genetic evaluation programs recent attention has been given to the development of genetic predictions that are more useful for determining the effects on profit and risk of alternative selection and mating decisions. This is in part due to the fact that many current national beef cattle evaluation programs contain EPD for indicator traits. It has been shown that considering EPD for indicator traits, especially when EPD for the economically relevant traits are available, will actually decrease the accuracy of prediction associated with a selection decision. Because properly formed EPD for economically relevant traits should consider the contribution of the indicator trait, using indicator trait EPD results in a redundancy that increases prediction error and confusion among cattle breeders. A precept has resulted from this renewed understanding that has been termed the principle of economically relevant traits. Using this principle it is possible to identify appropriate traits for inclusion in national beef cattle evaluation programs. The principle has led to an especially interesting set of recommendations for traits of carcass quality and yield. This is in part because of dogma and in part because carcasses are often valued based on traits that indicate a different desirable characteristic (e.g., marbling score versus tenderness, or subcutaneous fat thickness versus yield). Other livestock industries such as the swine industry have overcome these problems by using genetic predictions for amount of time to achieve finish endpoints. Work has begun to develop genetic predictions using random regression models for time to finish endpoints in beef cattle for weight, subcutaneous fat thickness, and quality grade. Having these three finish endpoint EPD will allow producers to not only predict the relative values of alternative selection decisions, but will also allow producers to predict appropriate finishing management programs for groups of slaughter cattle.

Key Words: Beef Cattle, Genetics, Prediction

409 Genetic influences on carcass merit of sheep. N. E. Cockett*¹ and G. D. Snowder², ¹Utah State University, Logan, UT, ²USDA, ARS U.S. Sheep Experiment Station, Dubois, ID.

Sheep numbers have decreased from nearly 30 million head in the early 1960s to 7 million head in 2000. Total production of lamb and mutton has not declined as sharply because of an increase in lamb carcass weight. From 1960 to 2000, the average lamb carcass increased from 22 kg to 31 kg. This change in carcass size is in part the result of improved feed management and an increase in mature size due to direct genetic selection and the use of large terminal sire breeds. Also, lambs are now frequently over-finished because the profit margin often favors larger animals and packers discount only extremely heavy lambs. Heavier carcasses have resulted in increased fat thickness, with the average carcass now exceeding recommendations by the American Sheep Producer Council's Consumer Acceptability Task Force for fat depth. It is possible to produce heavier carcasses with lean lamb characteristics using later maturing breeds, but current production systems have not capitalized on this opportunity. The proportion of lean meat cuts has remained constant in heavier carcasses, except in callipyge and Carwell animals. Lambs expressing these phenotypes have 30 and 8% increases in lean meat, respectively, with associated decreases in fat of 8 and 0%, respectively. However, almost all studies have found decreased tenderness of the callipyge loin. A similar effect on tenderness has not been reported for Carwell carcasses. Consumer consumption of lamb continues to fall, with annual per capita consumption of lamb and mutton dropping from 2.3 to 0.5 kg over the 1960 to 1997 time period. Studies of consumer preference indicate a lamb product with reduced fat and less intense flavor would be more appealing. These changes can be achieved through genetic selection and the choice of breeds. Identification of QTL for carcass merit will also aid in these improvements.

Key Words: Ovine, Carcass, Genetics

410 First generation of QTL searches for carcass traits in beef cattle. R. T. Stone*, USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.

Microsatellite-based linkage maps were developed with the expectation of being able to identify quantitative trait loci (QTL) emphasizing those traits for which phenotypic data were sex limited, expensive, or difficult to obtain. Currently, the publically available results for QTL searches for carcass traits are based on a few large half-sib families; five sires and approximately 1,000 offspring. Seven of these QTL are genome-wide significant (one false positive per 20 scans) while more than 20 are considered suggestive (one false positive per scan). Significant QTL affecting rib bone, carcass weight, dressing percentage (BTA5), predicted retail product yield (BTA2), marbling (BTA3), hot carcass weight (BTA4), and fat thickness (BTA8) have been reported. Of those QTL at the suggestive level of significance, some are for correlated traits at the same position or present in multiple families, indirectly suggesting that they are real. The first generation of QTL searches have demonstrated: 1) QTL with modest effects (0.5 standard deviations) can be detected, 2) the need for a much broader sampling of genetic variance, and 3) the need for sampling and statistical methods to detect interacting alleles. The second generation of QTL searches will likely be based on single nucleotide polymorphism (SNP) haplotypes because of their power in determining identity-by-decent and their suitability for high-throughput genotyping technology. The most logical resource populations will be half-sib families, many of which are small or have a limited number of offspring with phenotypic data. Thus, the power to determine identity-by-decent is critical for both QTL and candidate gene analysis. Recently, 120,000 bovine expressed sequence tags (EST) have been assembled into about 20,000 clusters. Thus, an emerging EST or gene-based genetic map will coalesce into the functional and comparative genomics of humans and model organisms. Undoubtedly, developments in genomics and genotyping technology will greatly impact future QTL studies in livestock and their utility in breeding programs.

Key Words: QTL Mapping, Carcass Traits

411 Dissecting the genetic control of carcass merit and meat quality in the pig. Max Rothschild*, Iowa State University.

Modern molecular biology and the science of genomics have opened up new and exciting possibilities to dissect complex phenotypic traits such as meat quality. To date over 4000 genes and markers have been added to the gene map of the pig. In addition to identifying and mapping genes and markers, animal geneticists have begun to search for the individual genes that affect meat and muscle quality in the pig. Meat and muscle quality traits are complex traits and some are often measured in a subjective manner. Measurement of these traits usually includes assessing backfat, intramuscular fat (marbling), loin eye area, pH, color, tenderness, juiciness, water holding capacity and flavor. For many of these traits heritabilities are moderate to high. While it is clear that these traits are likely to be controlled by many genes some individual genes may have large effects. To find these genes three approaches have been employed. The first has been to find or observe that "major" genes such HAL and RN are segregating in a population. The second approach is the "genomic scan" method which uses specialized crossbred resource families and random genetic markers to scan regions of the genome which are associated with meat quality traits. This approach has yielded many regions of the porcine genome associated with traits of carcass merit and meat quality. The final approach is the candidate gene approach and uses genes that by their very nature are expected to be associated with certain physiological functions. The purpose of this paper is to review

the remarkable progress made in identifying genes and genomic regions affecting meat quality traits in the pig.

Key Words: Pig, Meat Quality, Genetics

412 Validation of carcass merit quantitative trait loci (QTL's) and integration of QTL information into genetic programs for improvement of carcass merit. E. J. Pollak¹, M. E. Dikeman², C. Gill³, and D. W. Moser², ¹Cornell University, ²Kansas State University, ³Texas A&M University.

Genetic evaluations for traditional carcass characteristics have been published for limited numbers of sires by various beef breed associations. Collection of carcass information is difficult, which limits the amount of information generated for these traits. The routine carcass field data collected do not include observations for measures of tenderness or any information on sensory panel assessment of meat quality, prohibitive due to costs and logistics. An objective of the National Cattlemen's Beef Association's Carcass Merit Project (CMP) was to collect data on tenderness and sensory panel assessments along with the traditional carcass characteristics from a set of legacy bulls from all breeds participating in the project. These data are being used to provide information for the calculation of expected progeny differences (EPD's) and to validate the segregation of quantitative trait loci (QTL's), discovered in the Texas A&M Angleton Project, in these breeds. Eleven QTL's are being validated, six for Warner-Bratzler shear force, three for marbling, and one each for sensory panel tenderness scores and rib eye area.

Estimates of heritability for shear force measures on Simmental and Angus cattle in the project were 0.22 and 0.25, respectively. Genetic evaluations, ignoring QTL information, for Simmental bulls in the CMP result in a spread of sire EPD's of 0.45 kg of shear force. To date, nine bulls representing four breeds have completed the progeny test required and the DNA analysis in the CMP. Five of the six tested shear force QTL's have been found to be heterozygous ($p \leq 0.05$) in at least one bull. One of the nine bulls has been found to be heterozygous for the QTL for the sensory panel score of tenderness. The difference in progeny group performance, groups defined by which marker allele was inherited for the tenderness QTL, in one Simmental bull was almost as large as the spread in sire EPD's for that breed. A pleiotropic effect of one QTL (tested as a shear force QTL) with marbling has been found. Evidence

for segregation of the three marbling QTL and the rib eye area QTL has not been found in the nine tested bulls.

Key Words: Carcass traits, Quantitative trait loci, Expected progeny differences

413 Impact of breeding and genetics on poultry carcass and meat quality. D. L. Fletcher*, *University of Georgia, Athens, GA USA.*

The role of poultry breeding and genetics on carcass and meat quality issues has undergone constant change over the past 150 years. Early poultry breeding efforts were focused on such characteristics as fighting ability, egg production, and improving and maintaining the characteristics of pure bred stock. Poultry meat quality was not a major emphasis. After World War II, the poultry meat industry began to vertically integrate and with dramatic developments in nutrition, disease control, and management, the economics of production were so improved that poultry consumption skyrocketed. During this period, selection programs for commercial strains were also concerned primarily with economy of production including such factors, as growth rate, feed conversion, health, and uniformity. Quality issues included white feathering and fast feathering traits, as well as traditional livestock selection criteria for live animal and carcass conformation, fleshing, meat yield, and avoidance of skeletal defects. By the late 1970's through the 1990's, although most selection criteria were still related to economy of production, programs relative to market demands for increased breast meat yield and reduced carcass fat were given some attention. Other than for breast meat yield (both an economic and quality issue) and fat content, the only other area of selection interest relative to quality has been in attempting to reduce the PSE-like condition common in turkeys. With the dramatic changes in the marketing of broilers from a predominantly whole carcass market to further processed meat products, the issues relative to traditional quality attributes have almost completely disappeared. Current and future selection programs are likely to continue to focus on economy of production but may also begin to incorporate quality issues such as PSE-like conditions, meat and parts proportions (weights, thickness, "bun coverage", and trim waste), functional properties, possible composition modification (nutrient and health-based designer foods), and welfare.

Key Words: Poultry genetics, Poultry carcass quality, Poultry meat quality

Meat Thermoprocessing: Products and Processes

414 Thermoprocessing, products and processes: Introduction. S. M. Lonergan*, *Iowa State University.*

Development of new meat products continues to be a priority of meat processors interested in capturing and improving the inherent value of muscle foods. Pre-cooked products such as fully cooked bacon, beef crumbles and beef patties have been very successful in food service markets. Recently these products have gained a portion of the retail market. Growth of retail opportunities for these products is dependent on continued development of ingredient, processing, cooking and packaging technologies to ensure safety, consistency, quality and cost efficiency.

415 Thermodynamic cooking methods. J Gaydos*, *Stein Inc.*

The thermodynamic merits of various available cooking methods used for a variety of prepared meat products will be discussed.

Key Words: Thermodynamic, cooking, methods

416 Thermal processing and microbial stability. B.P. Marks*, *Michigan State University.*

Growth in the fully-cooked market sector and evolving federal regulations are creating a need for better information related to thermal inactivation of pathogens. In particular, federal regulations governing the safety of fully-cooked meat products are shifting from a command-and-control basis to performance standards. This shift increases the burden on processors to ensure that a new or modified process achieves target lethality levels. Although product characteristics (e.g., fat content

and pH) and process parameters are known to affect thermal resistance of bacteria, most reported information is from laboratory studies that encompass a limited range of conditions. The validity of using this information in evaluating process lethality is uncertain. Consequently, there is a significant need for validated technical tools that can be used to evaluate the lethality of dynamic cooking processes. This presentation will (1) summarize the current state-of-knowledge related to thermal inactivation of pathogens in meat products, (2) highlight limitations of available inactivation models, and (3) outline current research aimed at developing tools that are directly applicable to evaluating the lethality of commercial cooking processes.

Key Words: Pathogens, Cooking, Models

417 Enhancement of cooked meat quality and safety via packaging. Tom Rourke*, *Emmpak Foods, Milwaukee, WI.*

The standard packaging methods used to improve cooked meat quality and safety are vacuum and modified atmosphere. The efficacy of these systems is well documented when the residual oxygen level is 0.5% or less. Common modified atmosphere packaging (MAP) gas mixtures are 70-80% nitrogen and 20-30% carbon dioxide. Some success has been attained incorporating antimicrobial agents (fungicides, antibiotics, organic acids) directly into packaging films. Oxygen scavengers in the form of polymer additives of film-adhering packets have been extremely successful in preventing aerobic microorganisms, especially molds, on cooked meat products. Edible coatings and films as a final processed meat package is a promising area of research. They are commonly produced from lipids, polysaccharides or proteins and have several distinct advantages such as: biodegradability, edibility, excellent appearance and

oxygen barrier. In addition, these coatings and films can serve as a carrier for a variety of edible antimicrobial agents. Technologies designed to pasteurize processed meats after final packaging have received copious attention. Post pasteurization of vacuum packaged cooked products consists of hot water or steam immersion followed by immediate chilling. Irradiation (gamma, electron beam or X-ray) of cooked vacuum or MAP packaged products can produce very acceptable product at the correct

dose. High pressure processing involves submerging the packaged meat product in water increasing the pressure to 87,000 psi. The process has no effect on product color, texture, flavor, or package purge. Post pasteurization, irradiation and high pressure all increase product shelf life and significantly reduce pathogens.

Key Words: Packaging, Cooked meat, Food safety

Molecular Manipulation to Influence Mammary Development and Function

418 Physiological phenotypes of estrogen receptor knock-out mice. K.S. Korach*¹, ¹NIEHS/NIH, Research Triangle Park, NC..

Estrogen receptors (ER) play a crucial role in development and reproduction. Gene targeting allowed generation of mice homozygous for either the disrupted ER α (α ERKO) or ER β genes (β ERKO). α ERKO mice were unresponsive to uterotrophic assays with estradiol, hydroxy TAM, or DES. Estrogen, EGF or IGF-1 treatment to induce DNA synthesis in α ERKO uteri, even though EGF and IGF-1 signaling was shown to be intact by stimulation of c-fos also failed. Progesterone receptor mRNA was detected in α ERKO mice, but was not stimulated by estrogen in the uterus, mammary gland or ovary, indicating an estrogen dependent and independent gene regulation. α ERKO females are infertile and have hypoplastic uteri and hyperemic ovaries. The α ERKO ovarian phenotype occurs developmentally and can be reversed by a GnRH antagonist. Serum estrogen and LH are elevated compared to WT or β ERKO females. Analysis of the mammary glands of adult α ERKO females showed a primitive ductal rudiment rather than the fully developed ductal tree seen in WT or β ERKO mice. α ERKO males are also infertile, with atrophy of the testes and seminiferous tubule dysmorphogenesis resulting in decreased spermatogenesis and inactive sperm. Bone length is decreased in α ERKO of both sexes, but not in β ERKO mice. α ERKO males have reduced bone density and some alterations in cardiovascular function. Phenotypic differences were seen in sex and aggressive behavior in both α ERKO males and females compared to the patterns in WT or β ERKO mice. In contrast to the α ERKO, the β ERKO males are fertile with normal sexual behavior. Recent development of a viable double ER α/β -knock out shows a unique ovarian phenotype of transdifferentiation of granulosa to sertoli cells. Further characterization of the mice and comparison of the individual and double ER gene KO phenotypes will be required to more fully understand the physiological consequences of ER mediated actions and the specific roles of the two different forms of ER in estrogen hormone responsiveness.

Key Words: estrogen knockout, mammary , reproduction

419 Genetic manipulation of the IGF-I axis to regulate mammary development and function. D.L. Hadsell*, S.G. Bonnette, and A.V. Lee, *Baylor College of Medicine, Houston, TX.*

Insulin-like growth factor I is believed to regulate several processes within mammary epithelial cells during mammary gland development. Firstly, IGF-I stimulates cell cycle progression, in both normal mammary epithelial cells and in breast cancer cells. Secondly, IGF-I can stimulate milk protein gene expression and/or milk synthesis in a number of model systems. Lastly, IGF-I inhibits apoptosis in both normal mammary epithelial cells and breast cancer cells. Our laboratory has studied the IGF-I-dependent regulation of these processes by using transgenic and knockout mouse models that exhibit alterations in the IGF-I axis. Our studies on transgenic mice that overexpress IGF-I during pregnancy and lactation have demonstrated that this growth factor slows the apoptotic loss of mammary epithelial cells during the declining phase of lactation while having minimal effects during early lactation on milk composition or lactational capacity. In contrast, our analysis of early developmental processes in mammary tissue from mice which carry a targeted mutation in the IGF-I receptor gene suggests that IGF-dependent stimulation of cell cycle progression is more important to early mammary gland development than potential anti-apoptotic effects. With both models, the effects of perturbing the IGF-I axis are dependent on the physiological state of the animal. The diminished ductal development that occurs in response to loss of the IGF-I receptor is dramatically restored during pregnancy while the ability of overexpressed IGF-I to protect mammary cells from apoptosis does not occur if the mammary gland is induced to undergo forced involution. Data from our laboratory on the expression of IGF-signaling molecules in the mammary gland suggests that this effect of physiological context may

be related to the expression of members of the IRS, or insulin receptor substrate, family.

Key Words: Transgenic mice, Mammary, Apoptosis

420 Regulation of IGF signaling by IGF binding protein-3 in the mammary gland. Wendie Cohick* and Constance Grill, *Rutgers, The State University of NJ, New Brunswick, NJ/USA.*

The insulin-like growth factors (IGF) mediate mammary epithelial cell (MEC) growth and thus play a critical role in mammary gland growth and development. The biological activity of IGF is modulated by IGF binding proteins, a family of six structurally related yet distinct proteins. The immortalized bovine MEC line MAC-T synthesizes four forms of IGFBP. Under basal serum-free conditions, minimal IGFBP-3 protein is secreted. However, IGF-I specifically upregulates the synthesis of IGFBP-3, while having no effect on other IGFBP forms. Stable cell lines genetically engineered to constitutively express IGFBP-3 exhibit enhanced responsiveness to IGF-I in terms of DNA synthesis relative to mock-transfected cells (controls), suggesting that IGF-I regulation of IGFBP-3 acts as a regulatory loop that functions to increase IGF bioactivity. DNA synthesis is also increased relative to controls by factors that activate the IGF receptor but do not bind IGFBP, hence the mechanism does not require a physical interaction between IGF and IGFBP-3. IGF-I receptor number and affinity are similar between IGFBP-3 transfected and control cells. Therefore IGFBP-3 may enhance IGF action by directly influencing intracellular signaling events downstream of the IGF-I receptor. To investigate this, the signaling molecules that mediate IGF action in bovine MEC were first determined. IGF-I does not activate ERK 1/2, suggesting that IGF-I does not stimulate DNA synthesis via this MAP kinase pathway. In contrast, the p85 regulatory subunit of PI3 kinase co-precipitates with IRS-1 following stimulation with IGF-I, indicating involvement of the PI3 kinase signaling pathway. Activation of the downstream effector Akt is observed by 1 min and maximal by 15 min following exposure to IGF-I. Akt phosphorylation is greater at 1 min in MAC-T cells expressing IGFBP-3, relative to controls, and this enhanced activation is maintained through 10 h. In vitro kinase assays confirm that Akt activity is 1.4- to 1.9-fold higher in IGFBP-3 transfected cells. Therefore, IGFBP-3 may potentiate IGF-I activity by enhancing the activation of the PI3 kinase signaling pathway via Akt. Studies are in progress to further define the signaling molecules responsible for this effect.

Key Words: Mammary gland, Insulin-like growth factor binding protein-3, Signaling

421 Regulation of apoptosis during mammary involution by the p53 tumor suppressor gene. D. Joseph Jerry*¹, Ellen S. Dickinson¹, and Amy L. Roberts¹, ¹University of Massachusetts.

Regulation and functions of the p53 tumor suppressor gene have been studied extensively with respect to its critical role in maintaining the stability of genomic DNA following genotoxic insults. However, p53 is also induced by physiologic stimuli resulting in cell cycle arrest and apoptosis. In other situations, the activity of p53 must be repressed to prevent inappropriate removal of cells. The mammary gland provides a valuable system in which to study the mechanisms by which the expression and biological responses to p53 can be regulated under a variety of physiological circumstances. The proapoptotic role of p53 during involution of the post-lactating mammary epithelium is especially relevant to animal agriculture. We have utilized p53-deficient mice to establish the molecular targets of p53 in the mammary gland and biological consequences when it is absent. We have demonstrated that induction of the p21/WAF1 gene (Cdkn1a) is p53-dependent in the involuting mammary epithelium. Abrogation of p53 resulted in delayed involution of

the mammary epithelium demonstrating the physiological role of p53 in this process. Stromal proteases were induced in the mammary gland by 5 days post-weaning providing a p53-independent mechanism that resulted in removal of the residual secretory epithelium. These processes can be interrupted by treatment with hydrocortisone. These data establish p53 as a physiological regulator of involution that acts to rapidly initiate apoptosis in the secretory epithelium in response to stress signals. Therefore, p53 activity may be used as a physiological indicator to select treatments or animals with increased persistency of lactation.

Key Words: Mammary, Involution, p53

422 The Production and Regulation of Leptin in Bovine Mammary Epithelial Cells. J.L. Smith* and L.G. Sheffield, *University of Wisconsin-Madison, Madison, WI, USA.*

Western blot analysis indicated the presence of leptin in bovine milk, while reverse-transcription polymerase chain reaction (RT-PCR) indicated the presence of leptin mRNA in mammary tissue. Leptin was found to be produced by cultured bovine mammary epithelial cells (MAC-T cell line) by western blot and RT-PCR analysis. A real time RT-PCR method was developed that allowed quantitative assessment of bovine leptin mRNA over approximately 3 orders of magnitude. Time course studies indicated a rapid increase in leptin mRNA in response to insulin or IGF-I. When normalized against bovine GAPDH as an endogenous control, 30 minute or 1hr treatment with 10 ng/ml insulin gave 39±4 and 64±2 fold increase in leptin mRNA compared with 0hr control. Leptin mRNA was increased 257±9 and 75±23 fold by 30 minute or 1hr treatment with 10 ng/ml IGF-I. Dose response studies indicated significant increases in leptin mRNA in response to as little as 1 ng/ml insulin or 0.1 ng/ml IGF-I. Maximum increase in leptin mRNA was observed in response to 10 ng/ml insulin and 10 ng/ml IGF-1. These results indicate that production of leptin by bovine mammary epithelial cells can be regulated by factors known to alter mammary function and nutrient partitioning. This suggests that leptin may be an autocrine/paracrine signal in the bovine mammary gland.

Key Words: Leptin, Mammary epithelial cells, IGF-I

423 Mammogenic effects of estrogen and growth hormone are mediated by local changes in mammary IGF-1 and IGFBP-3. S. D. Berry*^{1,2}, T. B. McFadden^{1,3}, R. E. Pearson², and R. M. Akers², *¹AgResearch, Hamilton, New Zealand, ²Virginia Polytechnic and State University, Blacksburg, VA, ³University of Vermont, Burlington, VT.*

An epithelium-free mammary fat pad was surgically prepared in twenty-five one-month-old, Friesian heifers. At 18 months of age, the heifers were randomly assigned to one of four treatment groups. Treatments were: control (C), growth hormone (GH), estrogen (E) or growth hormone + estrogen (GE). Hormones were administered for 40 hours before the animals were sacrificed to provide mammary samples of parenchyma (PAR), intact fat pad (MFP), and epithelium-free or "cleared" fat pad (CFP). IGF-1 and IGF binding protein-3 (IGFBP-3) mRNA was higher in CFP and MFP than PAR ($P < 0.001$) whereas the protein products were higher in PAR ($P < 0.001$). IGFBP-2, a 28-kDa IGFBP and a 24-kDa IGFBP were more abundant in CFP and MFP. E ($P < 0.01$) and GH ($P < 0.05$) increased incorporation of ³H-thymidine into DNA of PAR by an average of 350% and 125% respectively. Incorporation of ³H-thymidine into DNA of MFP or CFP was minimal. Coincident with the changes observed in mammary epithelial proliferation, the overall effect of E was to increase IGF-1 protein content by 190%, 40% and 60% in MFP ($P < 0.01$), PAR ($P < 0.01$), and CFP ($P < 0.05$), respectively. E increased IGF-1 mRNA levels in MFP ($P < 0.08$), but not CFP, indicating that the regulation of IGF-1 expression is modulated by adjacent epithelium. GH and E reduced IGFBP-3 content in PAR to less than 40% of IGFBP-3 protein content in controls, whereas the 24-kDa IGFBP in CFP and MFP was increased to between 40% and 150% of controls. Increased proliferation of mammary parenchymal cells was associated with increased IGF-1 and reduced IGFBP-3 protein in mammary tissue. An increased ratio of local mammary IGF-1:IGFBP-3 likely mediates the stimulatory effects of GH and E in heifer mammary glands.

Key Words: Estrogen, Growth Hormone, Mammary

424 Influence of feeding level and bovine somatotropin (bST) on transforming growth factor-beta (TGF-β) and its receptor in mammary tissue of growing heifers. K. Plaut*¹, R. Maple¹, X. Cui¹, and S. Purup², *¹University of Vermont, Burlington, VT/USA, ²Danish Institute of Agricultural Sciences, Foulum/DK.*

Transforming growth factor-β is a potent inhibitor of mammary epithelial cell growth. The objective of this study was to determine whether TGF-β or its receptors were altered in heifers when mammary growth was altered. Twenty-four heifers weighing 195 kg were fed to gain at approximately 550 or 1100 gm/day for low or high feeding level, respectively. They were then treated for 35 days with bST injections (0 or 15 mg/day) at either high or low feeding level. Therefore, the treatments (n=6 per treatment) were low feeding level, placebo (LC), low feeding level, bST treated (LST), high feeding level, placebo (HC) and high feeding level, bST treated (HST). The heifers were slaughtered at approximately 230 kg live weight and mammary tissues were removed. TGF-β mRNA expression was analyzed using RNase protection assay and quantified by densitometric scanning. The type II TGF-β receptor was analyzed by competitive binding assay, immunohistochemistry and western blot analysis. TGF-β mRNA was normalized to 100 for HC and compared to all other treatments. The least squares mean for TGF-β mRNA expression was 112 for LC, 86 for LST, 222 for HST ± SEM of 80. Binding was expressed as cpm/100 micrograms of protein and was 8338 for LC, 7590 for LST, 9310 for HC, 4978 for HST ± 1396. Even though mRNA expression was approximately two-fold greater and receptor binding was one-half in animals fed to gain 1200 gm/day and treated with bST compared to all other treatments, differences were not significant due to large variability. Western blot analysis was used to determine that all tissue expressed both the Type I and II receptors. Immunohistochemistry revealed that receptors were localized in ductal and myoepithelial cells consistent with a role for TGF-β in regulating ductal morphogenesis. While TGF-β may play a role in mammary development, it does not seem to be regulated by somatotropin or plane of nutrition during early development.

Key Words: Mammary, Transforming Growth Factor-beta, Bovine Somatotropin and Feed Intake

425 The role of insulin in the modulation of milk fatty acid composition. B. A. Corl*¹, S. T. Butler¹, W. R. Butler¹, and D. E. Bauman¹, *¹Cornell University, Ithaca, NY.*

Milk fat fluidity is regulated by controlling the pattern of fatty acids that comprise the triglycerides. Specifically, shorter chain fatty acids and unsaturated fatty acids lower the melting point of the triglycerides. Δ⁹-desaturase plays an important role in regulating milk fat melting point by adding a *cis*-9 double bond to several medium and long chain saturated fatty acids. In several species, insulin regulates Δ⁹-desaturase gene expression. We utilized a hyperinsulinemic-euglycemic clamp to examine the role of insulin in regulating milk fatty acid composition and Δ⁹-desaturase in lactating cows. This involved continuous infusion of insulin to elevate circulating concentrations and maintenance of euglycemia by variable rates of glucose infusion. The treatment period was 4 days and commenced when cows were 10 DIM. Five cows received intravenous saline infusion (control) and four cows received the insulin clamp. Milk samples were collected two days prior to and during the treatment period. Plasma insulin concentrations were increased 8-fold during the insulin clamp as compared to cows infused with saline. Over the course of the experiment, milk fat yield and milk yield were reduced in cows receiving the insulin clamp. Milk fatty acid composition of cows during saline infusion did not change when compared to pre-treatment values. In contrast, cows receiving the insulin clamp had a decrease in milk fat content of long chain fatty acids as compared to pre-treatment values. Consequently, milk fat content of *de novo* fatty acids increased considerably during the insulin clamp. This effect was most obvious for C_{14:0} and C_{16:0} which increased 68% and 48%, respectively. The ratio of Δ⁹-desaturase fatty acid products to substrates serves as a proxy for Δ⁹-desaturase activity. Insulin infusion increased activity of Δ⁹-desaturase. Although milk fat content of C_{18:0} and *cis*-9 C_{18:1} was reduced 56% and 38%, respectively, the ratio of *cis*-9 C_{18:1} to C_{18:0} was increased 42%. Similar increases were observed for the ratio of *cis*-9 C_{14:1} and C_{14:0} (86%) and the ratio of *cis*-9, *trans*-11 CLA and *trans*-11 C_{18:1} (96%). These data indicate that insulin directly or indirectly regulates Δ⁹-desaturase and also milk fat content of long chain fatty acids presumably via effects on rates of lipolysis.

Key Words: insulin, desaturase

Packaging Food and Dairy Products for Extended Shelf-Life

426 Active packaging: Films and coatings for extended shelf life. Paul Dawson*, *Clemson University*.

Shelf life encompasses both safety and quality of food. Safety and spoilage-related changes in food occur by three modes of action; biological (bacterial/enzymatic), chemical (autoxidation/pigments), and physical. Active packaging may intervene in the deteriorative reactions by; altering the package film permeability, selectively absorbing food components or releasing compounds to the food. The focus of this report will consider research covering impregnated packaging films that release compounds to extend shelf life. The addition of shelf life extending compounds to packaging films rather than directly to food can be used to provide continued inhibition for product stabilization. For further-processed foods with greater than one week shelf life, active packaging can provide an added level of protection downstream in the distribution cycle. Direct addition of antimicrobials for instance, will have a strong initial effect but will have little effect later in the distribution cycle since the antimicrobial will react with food components or be absorbed into the food bulk. For non-fluid foods, the deteriorative reactions occur primarily at the food surface. Thus, less antimicrobial will be needed when used in the package since the compound will be released at the location of need, the food surface. Some research results will be highlighted that focus on using compounds that are either approved for food use or are food components. Antimicrobials used include nisin, lauric acid, and EDTA while antioxidants added to films include BHT, BHA, and rosemary extract. Film and coating materials include soy, wheat, corn, and polyethylene. Pathogens including Salmonella and Listeria have been inhibited by several combinations of antimicrobials and film or coating types. Fresh beef color has been extended by over-wrapping meat with BHA-impregnated polyethylene film and inoculated milk exposed to films containing nisin have had multiple log reduction of Listeria monocytogenes. Positive results for food shelf life extension have been shown by the application of active packaging.

Key Words: antimicrobial packaging, shelf life, active packaging

427 Mold migration in paperboard materials for extended shelf-life milk. J. E. Marcy*¹, L.D. Sammons², S.S. Sumner¹, and C.R. Hackney³, ¹*Virginia Tech*, ²*International Dairy Foods Assoc.*, ³*West Virginia University*.

Research was conducted to elucidate the cause of past fungal contamination experienced by a local dairy in extended shelf-life fluid dairy products. Migration of *Penicillium spinulosum* from paperboard to milk during an extended shelf-life was investigated through inoculation of conidia into paperboard test-squares. These 57.2 cm by 57.2 cm test-squares were sealed on three sides with melted paraffin wax, inserted with a steel pin at 3.2, 6.4, 9.5 and 12.7 mm from the uncoated edge and sterilized by gamma irradiation. A stock solution of *P. spinulosum* was injected at these four distances and the injection site sealed with melted paraffin wax. The squares were incubated at 7 C. in ultra-pasteurized skim milk for 60 days, allowing wicking of the milk to occur. An inverse relationship was seen between distance from the uncoated edge and presence of the test organism in the surrounding milk. The percentage of *P. spinulosum* was 84% at 3.2mm, 72% at 6.4mm, 50% at 9.5mm and 28% at 12.7mm. Survival of *P. spinulosum* was in paperboard test materials was studied.

Key Words: Paperboard , Extended Shelf-life

428 The use of polymeric materials for extended shelf life products. Susan Nielsen*¹, ¹*Eastman Chemical Company*.

The consolidation of dairies, centralization of meat packing operations, and expansion of distribution areas has led to an increase in the need for products with an extended shelf life. The challenge to the food industry is to meet this need while maintaining product quality and not compromising flavor or consumer acceptance. Plastics play an important role in meeting the challenge of extended shelf life. They offer unique advantages in food packaging to both producers and consumers. This talk will look at some of the common polymers used in food packaging, their properties, and how these properties can be used to meet food quality, processing, and storage requirements. The use of plastics in the packaging will be highlighted in a discussion of two products with extended

shelf life, ESL milk and case-ready meat. In the last two years, there has been substantial growth in extended shelf life milk packaged in single serve PET or HDPE containers. The combination of ESL processing and a plastic container results in an extended shelf life of 60 to 90 days, and at the same time provides consumers with the attributes they are demanding from the package: convenience, portability, and resealability. The second example of how polymers are part of the solution to extend shelf life is focused on case-ready beef. Here, a combination of a polymer with the appropriate gas barrier and a modified atmosphere allows beef to retain its bright red color longer, extending its shelf life. Plastics are increasingly used in food packaging and will be part of the future of extended shelf life products.

Key Words: Shelf life, Polymer, Plastic

429 Exploring Product-Package Research in an Interactive Session . J. C. Acton*, *Clemson University*.

Three differing research areas (presented from invited posters) which address current product-package developments will be critiqued with audience participation. After an overview of the research areas, challenging questions will be provided, and those in attendance will actively engage in a brainstorming discussion. The objective is to foster thoughts on what if, why not, spin-offs, the future, and does it matter.

Key Words: Food Packaging, Brainstorming Packaging, Product-Package Developments

430 Potential of biobased materials for food and dairy packaging. Grete Bertelsen*¹, V.K. Haugaard¹, and T.H. Hansen¹, ¹*Department of Dairy and Food Science, The Royal Veterinary and Agricultural University*.

Biobased food packaging materials are defined as packaging materials derived from renewable sources. Generally, biobased materials are potentially biodegradable, i.e. composting is a potential technique for waste management. Biobased packaging materials include both edible coatings and edible films along with primary and secondary packaging materials. This presentation will focus on biobased primary packaging.

Biobased materials can be classified according to the method of production, resulting in the following three main categories: 1) Polymers directly extracted/removed from natural materials (mainly plants) as, for example, starch, cellulose, casein and wheat gluten, 2) polymers produced by "classical" chemical synthesis from renewable bio-derived monomers as, for example, polylactate, a biopolyester polymerised from lactic acids monomers and 3) polymers produced by microorganism as, for example, the polyhydroxyalkanoates. This presentation will review the wide range of biobased materials and their properties in relation to food packaging.

Prior to commercial use of biobased primary packaging materials several concerns must be addressed. First of all the biobased material must remain stable during storage of the food products, maintaining the mechanical and/or barrier properties. Ideally, the materials should biodegrade efficiently on disposal. Thus, environmental conditions conducive to biodegradation must be avoided during storage, whereas optimal conditions for biodegradation must exist after discarding. In order to reduce deterioration of the food products it is also important that the biobased packaging material meets the requirements of the individual food products. In this presentation the suitability of biobased materials as food packaging will be evaluated. In addition the challenges involved in using biobased packaging materials for different food and dairy products will be identified.

Key Words: Biobased materials, Packaging, Food and dairy product

431 Quality attributes of strawberry swiss style yogurt in the North Carolina marketplace. A. Hansen* and M. Keziah, *North Carolina State University Raleigh, N.C. USA.*

Approximately 300 samples of strawberry swiss style yogurt were obtained from various local dairies and grocery stores across North Carolina. The samples were collected over a two year period and analyzed for appearance, body, texture and flavor. The evaluation was conducted with 15 trained dairy judges according to ADSA protocol. The variation in quality and uniformity was quite extensive across brands. The color went from white to pink to purple for strawberry yogurt. The body and texture was from a runny liquid to a firm gel. The flavors were from slight strawberry, strawberry, chocolate and banana for swiss style strawberry yogurt. The major appearance defects were most to least color leaching, lacks fruit, lumpy, shrunken, free whey and atypical color. The body and texture defects from most to least were gel-like, weak, ropy and grainy. The flavor defects from most to least were acetaldehyde, high acid, lacks flavoring, unnatural flavoring and too sweet. In most cases the national brands had fairly good strawberry flavor but poor color and gel-like body. The store brands had appearance and colors from white or pink to purple. In many of the store brands we observed color leaching, no fruit and lacks fruit. The body and texture in most cases were gel-like with less samples grainy, weak and ropy. The flavoring of the store brands we identified were acetaldehyde, high acid, lacks flavoring, too sweet, banana and chocolate. It is evident that more quality assurance is needed to improve the quality of strawberry swiss style yogurt

Key Words: Swiss Style Yogurt, Marketplace, Quality

432 Consumer acceptability of lucuma and cherimoya ice cream. A. Hansen*¹, M. Keziah¹, and T. Salas², ¹*North Carolina State University Raleigh, N.C. USA,* ²*Gen Peru Lima, Peru.*

Raw milk and cream were obtained from the NCSU dairy plant to produce a 14% fat ice cream. Powdered skim milk was used to raise the milk solids to 9%. Granulated cane sugar was used at the rate of 15% and ice cream stabilizer was at 0.3%. The ingredients were blended and batch pasteurized at 165° F for 30 minutes and then homogenized at 2000 psi on first stage and 500 psi on second stage. The mix was then cooled to 35° F with chill water. The mix was aged for 48 hours and then flavored with frozen lucuma and cherimoya puree. The mix was frozen in a Cherry Burrell Vogt Freezer at 85% overrun, packaged in half-gallon containers and placed in a -30° F hardening freezer. Approximately three weeks later ice cream was removed from the hardening box and tempered at 0° F for sensory testing. Twenty-eight consumers screened for ice cream use participated in a consumer hedonic panel to measure degree of liking of lucuma and cherimoya ice creams. Panelists used a nine-point hedonic scale ballot to rate overall impression, flavor and mouthfeel. Statistical analysis of the sample results reveals that consumers scored the lucuma ice cream overall impression and flavor significantly higher than that of the cherimoya ice cream. The overall impression and flavor scores for the lucuma sample averaged in the "like moderately" to "like very much" range while the cherimoya sample averaged in the "neither like nor dislike" range. Consumers failed to reject the null hypothesis of no difference in mouthfeel. A preference for the lucuma ice cream overall impression and flavor can be inferred from these hedonic scores.

Key Words: Lucuma, Cherimoya, Ice Cream

433 Effect of CO₂ Addition to Raw Milk on Protein and Fat Degradation at 4°C. Y Ma* and David Barbano, *Northeast Dairy Foods Research Center, Department of Food Science, Cornell University.*

Fresh raw milks, with low (3.1x10⁴ cell/ml) and high (1.1x10⁶ cells/ml) somatic cell count (SCC), were standardized to 3.25% fat and from each a preserved (with 0.02% potassium dichromate) and an unpreserved portion were prepared. Subsamples of each portion were carbonated to contain 0 (control, pH 6.9), and 1,500 (pH 6.2) ppm CO₂, or HCl acidified to pH 6.2. Results of HCl acidified milk helped explain if there was a direct CO₂ effect or simply a pH reduction effect. Samples were stored in gas-tight glass jars at 4°C and analyzed on d 0, 7, 14, and 21

for proteolysis (decrease of CN as a percentage of true protein), lipolysis (increase in free fatty acid), and microbial count. As expected, more proteolysis and lipolysis occurred in high SCC milk. For unpreserved milks at d 21, psychrotrophic bacteria count reached 10⁸ cfu/ml for both control and HCl acidified samples; in CO₂ added sample, the count was ca. 10⁶ cfu/ml. At d 21, for control and HCl acidified unpreserved milks, average CN as a percentage of true protein decreased from 81 to 68% and average free fatty acid increased from 0.18 to 0.28 meq/kg milk primarily due to microbial growth; average changes were 81 to 80% and 0.18 to 0.19 meq/kg, respectively, for CO₂ added milk. Microbial growth was effectively inhibited in all preserved milks. Data for preserved milk gave information regarding the direct impact of CO₂ on protein and fat degradation by native milk enzymes separated from degradation brought about by enzymes of microbial origin. Compared with control, both carbonated and acidified preserved milks showed less proteolysis, suggesting that the inhibitory effect of CO₂ on proteolysis was due to pH reduction. No effect of CO₂ or acidification on lipolysis in preserved samples was observed. Carbonation reduced microbial growth in raw milk at 4°C and slowed down proteolysis as a consequence of milk pH reduction. High quality raw milk (low initial bacteria count, low SCC) with 1,500 ppm CO₂ can be stored at 4°C for at least 21 d with minimal protein and fat degradation, i.e., with < 1% decrease in CN as a percentage of true protein and < 0.01 meq/kg increase in free fatty acid.

Key Words: Carbon Dioxide, Prolonged Storage of Raw Milk, Protein and Fat Degradation

434 Effect of storage time and temperature on the serum phase of cultured cream cheese. L Acosta and P.S. Kindstedt*, *University of Vermont, Burlington, VT/USA.*

Syneresis is a problem in Cream cheese that is characterized by whey separation at the cheese surface and general wheying-off during heating. Previous studies demonstrated that the water-holding capacity of cultured Cream cheese decreased during storage at 4° and 25° C, and that changes occurred much more rapidly at 25° C. The objective of this study was to evaluate time and temperature dependent changes in the composition and viscosity of the serum phase of Cream cheese. Four 13.6-kg blocks of cultured Cream cheese made with locust bean gum stabilizer were obtained from a commercial source within 10 d after manufacture. Blocks were sectioned into samples that were vacuum packaged and randomly assigned to one of two storage temperatures: 4° and 25° C. Samples were randomly chosen for analysis after 1, 4, 7, 10, 14, 21 and 28 d of storage at 25° C, and after 0, 14, 27, 41, 55, 69, 83, 96 and 111 d of storage at 4° C. Samples were centrifuged at 12,500 x g for 75 min at 25° C to obtain expressible serum (ES). The ES was analyzed for crude protein, Ca, P, K, Mg, Na, Zn, and viscosity. For each storage temperature, RCB ANOVA was used to determine the significance of changes during storage. Linear regression was used to compare rates of change at 4° and 25° C. The amount of ES increased significantly during storage at 4° and 25° C; the rate of increase was substantially greater at 25° C. Crude protein in the ES increased significantly but only slightly during storage at 25° C, and did not change significantly at 4° C. Mineral contents did not change significantly at either storage temperature. In contrast, the viscosity of ES decreased significantly during storage at 4 and 25° C; the rate of decrease was much greater at 25° C. The amount and viscosity of the ES showed an inverse exponential relationship (R = .85). The results suggest that decreased water-holding capacity of Cream cheese during storage is caused by changes in the stabilizer function and not by changes in the distribution of protein and minerals between the protein-fat matrix and serum phases.

Key Words: Cream cheese, Syneresis, Expressible serum

435 Effect of storage time, storage temperature and pH on the viscosity of aqueous solutions of locust bean gum. M.L. Gigante*¹, M. Almendra-Aliste², and P.S. Kindstedt², ¹*State University of Campinas, Campinas, SP/Brazil,* ²*University of Vermont, Burlington, VT/USA.*

Previous studies demonstrated that the viscosity of the serum phase of cultured cream cheese (made with locust bean gum stabilizer) decreased in a temperature-dependent manner during storage at 4 and 25°C. The

objectives of this study were to determine whether aqueous solutions of locust bean gum (LBG) undergo similar temperature-dependent changes in viscosity during storage, and whether pH influences those changes. LBG solutions (.15, .30, .45, and .60%) were prepared in distilled water. Finely powdered LBG was sifted slowly into the vortex of rapidly stirred (9000 - 1,200 rpm) water at 84 °C. The solutions were then stirred at room temperature for 4 h and then held undisturbed for 16-18 h at 4°C. The solutions were then divided into three treatments and lactic acid was added to adjust the pH to 5.3, 4.8 and 4.3 ($\pm .05$). The acidified solutions were dispensed into sterile culture tubes and stored at 4 or 20°C for up to 28 d. Samples were randomly chosen after 1, 4, 8, 12, 16, 20, 24 and 28 d and analyzed for viscosity at 25°C (Brookfield) and turbidity (absorbance, 420 nm). The entire experiment was replicated three times. For each LBG concentration, the effects of pH, storage time and storage temperature were evaluated by ANOVA according to a split split-plot design. The viscosity of LBG solutions decreased and turbidity increased significantly during storage. These changes were greater at 20°C than at 4°C. Also, viscosity decreased more rapidly at higher pH. The observed changes in turbidity and viscosity indicate that the state of the LBG stabilizer changed during storage, possibly due to self-association. It is possible that similar changes may occur in LBG contained within the serum phase of cream cheese. Thus, changes in stabilizer function may account for the previously observed changes in the serum phase of cultured cream cheese during storage. Finally, results of the present study suggest that the pH of cream cheese may influence the rates at which the serum viscosity and water-holding capacity of the cheese decrease during storage.

Key Words: Cream cheese, Stabilizer, Locust bean gum

436 Application of a model system to study the effect of pH on the serum phase of cultured cream cheese during storage. M.L. Gigante^{*1}, M. Almena-Aliste², and P.S. Kindstedt², ¹State University of Campinas, Campinas, SP/Brazil, ²University of Vermont, Burlington, VT/USA.

Previous studies demonstrated that the viscosity of locust bean gum (LBG) in aqueous solution decreased during storage and was affected by storage temperature and pH of the solution. The present objective was to determine whether the pH of cream cheese influences temperature-dependent changes in the serum phase during storage. Three 13.6-kg blocks of cultured Cream cheese made with LBG were obtained from a commercial source within 15 d of manufacture. Blocks were sectioned into samples that were randomly assigned to three treatments. A model system was used to change cheese pH. One group of samples was exposed to volatile ammonia to increase the pH to ca. 5.2. A second group was exposed to volatile acetic acid to decrease the pH to ca. 4.5. A third group served as a control (pH ca. 4.8). Samples from each pH treatment were vacuum packaged and randomly assigned to one of two storage temperatures: 4 and 20°C. Samples were randomly chosen for analysis after 4, 8, 12, 16, 20, 24 and 28 d of storage. Samples were centrifuged at 12,500 x g for 75 min at 25°C to obtain expressible serum (ES). The ES was analyzed for viscosity at 25°C (Brookfield) and turbidity (absorbance, 420 nm). Effects of pH, storage time and storage temperature were evaluated by ANOVA according to a split split-plot design. Amount of ES increased significantly during storage, and was affected by storage temperature and cheese pH. Significantly more ES was obtained at higher temperature and higher pH. Viscosity of ES decreased significantly during storage and was affected by storage temperature and cheese pH. Viscosity decreased more rapidly at higher temperature and higher pH. Turbidity of ES was not affected by storage temperature or cheese pH. The observed changes in amount and viscosity of ES during storage suggest that the state of LBG within the serum phase of the cheese changed in a temperature and pH-dependent manner. However, in contrast to LBG in aqueous solution, these changes could not be detected by measuring the turbidity of ES, possibly due to the centrifugation conditions used to obtain ES.

Key Words: Cream cheese, Stabilizer, Locust bean gum

437 Effect of centrifugation conditions on expressible serum obtained from cultured cream cheese. M. Almena-Aliste^{*1}, M.L. Gigante², and P.S. Kindstedt¹, ¹University of Vermont, Burlington, VT/USA, ²State University of Campinas, Campinas, SP/Brazil.

Previous studies showed that the amount and viscosity of expressible serum obtained from cream cheese varied significantly from batch to batch and with temperature and time of storage. The objective of this study was to evaluate the effect of centrifugation conditions on expressible serum in an attempt to gain insight into the causes of variation in serum viscosity and cheese water-holding capacity. Cream cheese was obtained from a commercial source and centrifuged at 3 different forces (13,000, 16,000, and 20,000 x g) and 2 different temperatures (cheese pretempered to 25 °C, centrifuged at 25 °C; cheese pretempered to 60 °C, centrifuged at 25 °C). Three replications were performed at each force x temperature combination. Expressible serum was analyzed for viscosity at 25 °C (Brookfield), turbidity (absorbance, 420 nm) and total solids. Data were analyzed by ANOVA according to a 3x2 factorial design. Six different batches of cheese that varied widely in properties were evaluated using this experimental design. Centrifugation force significantly affected the amount of ES obtained from all six cheeses, but significant interactions of force x temperature occurred with three of the cheeses. In general, higher g-force resulted in greater ES. Total solids decreased slightly (< 0.2%) but significantly with higher centrifugation force. In contrast, viscosity was not affected by centrifugation force in 5 of 6 trials. Turbidity results varied widely among cheeses and were inconclusive. The data suggest that functioning stabilizer in the serum is not sedimentable at up to 20,000 x g. Centrifugation temperature significantly affected viscosity and turbidity in 5 of the 6 trials. Higher centrifugation temperature resulted in higher viscosity and higher turbidity. In contrast, total solids varied only slightly (< 0.3%) between temperatures, and the effect was not consistent from trial to trial. The data suggest that the higher cheese temperature before and during centrifugation altered the state of the stabilizer and enhanced its water-binding capacity and ability to increase the viscosity of the serum phase of the cheese.

Key Words: Cream cheese, Expressible serum, Stabilizer

438 Isolation and characterization of gritty particles in cream cheese. Mihir R. Sainani^{*}, Harit K. Vyas, and Phillip S. Tong, California Polytechnic State University, San Luis Obispo, CA.

A gritty/grainy mouthfeel is an undesirable textural defect in cream cheese. Grittiness develops when the coagulated curd (pH 4.55 - 4.6) is heat-treated during cheese making. The objectives of this study were 1) to isolate and characterize gritty particles from cream cheese and 2) to study the effect of gritty particles on texture of the cheese. Gritty particles were isolated from cream cheese by washing with water at 25°C and then 50°C. The mixture was then cooled and held overnight at 10°C and the top fat layer was decanted. These steps were repeated 4-5 times to get a good isolation of the particles. The particulate suspensions were used for estimating particle size using Coulter LS230 particle size analyzer. The suspensions were subsequently vacuum filtered through 2.5 µm filter. The filtered particles as well as cheese were analyzed for moisture, fat, protein and ash using standard AOAC methods and lactose was estimated by the difference. To study the effect on the cheese texture, gritty particles were added at 5, 15 and 25% (w/w) levels to smooth cream cheese and a sensory ranking test was done on the samples (15 panelists). In another experiment, the isolated particles were further separated into two size classes of 8 to 130µm and $\geq 130\mu\text{m}$ using filters. These particles were then mixed with smooth cream cheese at 16 and 29 % (w/w) and a sensory test was conducted on these samples. It was found that the particles were 26% (dry matter basis) higher in protein content and 66 and 63% (dry matter basis) lower in ash and lactose, respectively, as compared to the cheese. The particle size was in the range of 0.42µm to 1500µm. Sensory results suggested that the cream cheese added with particles even at 5% level was perceived as more gritty than the control sample. It also revealed that the perceived grittiness increased with increase in the amount and size of particles. It was concluded that particles were higher in protein content than the cheese and that the size and number of particles affected the grittiness of cream cheese.

Key Words: Grittiness, Cream Cheese

439 Fortification of fluid skim milk with conjugated linoleic acid (CLA). W.S. Campbell*, J. Parker, M.A. Drake, and D.K. Larick, ¹North Carolina State University.

Nutraceutical products make up the fastest growing segment of the U.S. food industry. Conjugated linoleic acid (CLA) occurs naturally in milk at low levels and is an anticarcinogen. Research indicates that concentrations of 1 to 3 g CLA/day would provide protective anticarcinogenic benefits. Increased levels of CLA in fluid milk would produce a nutraceutical dairy beverage. The objectives of this study were to develop a CLA fortified milk with improved nutritional properties. CLA (1 g, 2g, or 3 g /240g) and derivatized whey protein concentrate (DWPC) (0%, 0.25%, 0.5%) were added to raw skim milk prior to homogenization, HTST pasteurization and aseptic packaging. Headspace volatiles

were evaluated by purge and trap gas chromatography. Viscosity was determined using a controlled stress rheometer and visual properties (L^* , a^* , b^*) were evaluated with a colorimeter. CLA fortified skim milk had minimal levels of hexanal and sensory data did not indicate substantial flavor deterioration as compared to control. The addition of CLA increased the whiteness of the milk, but did not significantly affect viscosity. Addition of DWPC at .25% in skim milk mimicked the viscosity of reduced fat milk, however, visual properties were not affected. These results indicate that skim milk may provide a vehicle for CLA consumption and that DWPC enhances the viscosity of skim milk such that it is more similar to reduced fat milk.

Key Words: Conjugated linoleic acid, Milk

ASAS Nonruminant Nutrition: Alternative Ingredients (Nursery & Specialty Grain)

440 Supplementation of α -1,6-galactosidase and β -1,4-mannanase to improve soybean meal utilization by nursery pig. S. W. Kim*¹, I. Mavromchalis², and R. A. Easter², ¹Texas Tech University, ²University of Illinois.

Soybean meal contains 5.6% α -galactoside and 1.2% β -galactomannans that pigs can not utilize because of they lack appropriate enzymes, resulting in gas production and flatulence. Two experiments were conducted to test a hypothesis that dietary supplementation of an enzyme mixture (carbohydrase, mainly composed of α -1,6-galactosidase and β -1,4-mannanase) improves nutrient utilization of soybean meal in nursery pigs. In the first experiment, 108 weaned pigs (21 d; Camborough-15 x line 326, PIC, Franklin, KY) were offered three diets containing either 0% (control), 0.025%, or 0.050% of the carbohydrase for a 5-wk period in six replicates with 6 pigs per pen. Overall, growth response of pigs fed diets containing enzyme was greater ($P < 0.05$) than control group (11% improvement compared to control). Average daily gain was greater ($P < 0.07$) only in pigs fed a diet with 0.025% carbohydrase during the fourth wk post-weaning. There was no improvement in average daily gain in pigs fed a diet with 0.050% of carbohydrase. However, gain/feed ratio was greater ($P < 0.05$) in pigs fed a diet with 0.025% of enzyme during the last 4 wk of the experiment. In the second experiment, ten cannulated female pigs (Camborough-15 x line 326, Pig Improvement Company) were used to measure the effect of the carbohydrase supplementation (0.025%) on the apparent ileal digestibility of energy and amino acids with five pigs assigned to each treatment. Ileal samples were collected for 2-d following by 5-d adjustment period during the fifth wk post-weaning. Apparent ileal digestibility of gross energy was greater (7% improvement, $P < 0.05$) in the carbohydrase-supplemented diet. Also, apparent ileal digestibility of lysine, threonine, and tryptophan was greater (3% improvement, $P < 0.05$) in the carbohydrase-supplemented diet. In conclusion, a carbohydrase composed of α -1,6-galactosidase and β -1,4-mannanase can increase growth performance in nursery pigs by improving the digestibility of energy and amino acids in corn-soybean meal-based diet.

Key Words: Nursery pigs, Soybean meal, Carbohydrase

441 Performance of weaned piglets fed insect-protected (MON 810) or near isogenic corn. G. Piva*¹, M. Morlacchini², A. Pietri¹, A. Piva³, and G. Casadei¹, ¹Istituto di Scienze degli Alimenti e della Nutrizione, U.C.S.C., Facolt di Agraria, Italy, ²CERZOO, ³DIMORFIPA, Facolt Medicina Veterinaria, Bologna, Italy.

The aim of the experiment was to compare the nutritive value for piglets of insect-protected corn (Bt) containing the Cry1A(b) protein (MON 810) with non-modified near isogenic control corn (IC), both produced on two Italian farms located in Lodi and Venezia provinces. The trial utilised 128 weaned Large White piglets weighing 8.8 (1.27) kg. Animals were divided into 4 treatments of 32 animals each (4 pens each of females and castrated males each with 4 pigs/pen). Five climate controlled rooms each containing 6 pens except the fifth room containing 8 pens were used. Treatments were blocked by sex and treatment within each room. Nutritional analytes were not different ($P < 0.05$) between IC and Bt corn. Animals were fed test diets containing 33% corn for 35 days. Feed intake of pigs did not differ ($P < 0.05$) among experimental diets. Feed:gain was not different ($P < 0.05$) among treatments during any period on study (0-14 d, 15-35 d and 0-35 d). Overall ADG was 5.6%

higher ($P < 0.05$) for Bt corn fed pigs (396 g/d) compared with IC pigs (375 g/d). Pigs fed the B.t corn had 2.8% heavier final live weights (22.6 kg) compared to the IC corn fed pigs (22.0 kg) ($P < 0.05$). Differences in performance may be attributed to Bt corn having a 69% lower level of fumonisin B₁ than IC corn and 14.4% lower deoxynivalenol (DON). We conclude that performance of piglets fed Bt corn is at least as good as those fed IC corn.

Key Words: Pigs, Transgenic corn, Mycotoxins

442 Effects of feeding blends of grains naturally-contaminated with *Fusarium* mycotoxins on growth and brain regional neurochemistry of starter pigs and the efficacy of supplemental yeast cell wall polymer in detoxification. H.V.L.N. Swamy¹, T.K. Smith¹, E.J. MacDonald², and A.E. Sefton³, ¹University of Guelph, Guelph, Ontario, Canada, ²University of Kuopio, Kuopio, Finland, ³Alltech Biotechnology Center, Nicholasville, Kentucky, USA.

Naturally-contaminated grains have been reported to be more toxic than equivalent amounts of purified mycotoxin based on chemical analysis. An experiment was conducted, therefore, to determine the effect of feeding a blend of grains naturally-contaminated with *Fusarium* mycotoxins to starter pigs and to test the efficacy of a polymer extracted from yeast cell wall as a dietary treatment for *Fusarium* mycotoxins. A total of 175 starter pigs (initial weight of 10 kg) were fed 5 diets (7 pens of 5 pigs per diet) for 21 days. Diets included a control, a blend of contaminated grains and contaminated grains + 0.05, 0.10 and 0.20% yeast cell wall polymer (MTB-100, Alltech Inc.). Diets containing contaminated grains averaged 3.85 ppm deoxynivalenol, 26.88 ppm fusaric acid and 0.4 ppm zearalenone. Weight gain of all pigs fed contaminated grains was significantly reduced compared to control especially in the first week of feeding. The feeding of contaminated grains significantly reduced concentrations of dopamine in the hypothalamus and concentrations of norepinephrine in the pons. The ratio of 5-hydroxyindoleacetic acid to serotonin was also elevated in pons. The feeding of 0.2% yeast cell wall polymer largely prevented these neurochemical changes. It was concluded that the feeding of grains naturally-contaminated with *Fusarium* mycotoxins can alter brain neurochemistry in starter pigs and that the changes can largely be prevented by the feeding of yeast cell wall polymer at the appropriate concentrations although this may not be reflected in increased growth rate.

Key Words: Pigs, *Fusarium*, Deoxynivalenol

443 Influence of type of cereal and level of fiber on performance of early-weaned piglets. G. G. Mateos*¹, A. Alcantarilla¹, M. A. Latorre¹, R. Lazaro¹, E. Gomez², and N. Laso², ¹Universidad Politecnica de Madrid. Spain, ²Centro de Pruebas de Porcino. Junta Castilla y Leon. Spain.

A trial was conducted to investigate the influence of type of cereal and level of crude fiber used in the diet on performance of early weaned piglets. There were eight treatments and eight replicates per treatment with 5 piglets (blocks 1 and 2) or 12 piglets (blocks 3 and 4) per replicate. The control diet included 8% fish meal, 15% dried whey, and 12% fullfat soy bean, and contained 52% of cooked and expanded corn. Treatments B, C, D, and E substituted 30% of the corn for 30% of cooked decorticated oats, cooked oats, cooked rice, and raw oats, respectively.

In addition, other three extra diets (F, G, and H) were formulated in which approximately 2.6% of cooked and expanded oat hulls were added to diets A, B, and D. Convenient non-orthogonal comparisons were conducted to test the effects of supplemental fiber (ABD vs FGH), source of cooked cereal (AF vs BG vs DH), heat processing of oats (E vs C), and dehulling of oats (B vs C) on piglet performance. At the end of the trial (42 d of age), fiber inclusion did not affect feed intake, daily gains or feed conversion ($P > 0.05$). Piglets fed cooked rice outperformed piglets fed any other cereal and showed the best gains and feed conversion (347, 317, 311 g/d; $P < 0.05$ for growth, and 1.51, 1.57, and 1.63 g/g; $P < 0.05$ for feed conversion for rice, corn, and decorticated oats, respectively). Cooking and expanding the oats improved both daily gains (303 vs 295 g/d) and feed conversion (1.55 vs 1.64 g/g) but the differences were not significant ($P > 0.05$). Dehulling the cooked oats had no impact on piglet performance. It is concluded that rice is a cereal of choice in diets for early-weaned piglets. Increasing the level of fiber of the diet by adding cooked and expanded oat hulls did not impair piglet performance. Data on cost and on productive performance should be taken into account when deciding type of cereal to use in diets for early weaned piglets.

Key Words: Heat processing, Oat hulls, Piglets

444 Singular and combined efficacy of two new microbial phytases in corn-soy or corn-soy-wheat diets for young pigs. C.H. Stahl*, J.M. Porres, K.R. Roneker, and X.G. Lei, Cornell University, Ithaca, NY.

We have expressed a heat-stable phytase from *Aspergillus fumigatus* (AP) and a catalytically-efficient phytase with low pH optimum from *Escherichia coli* (EP) in a yeast system. Two experiments were conducted to compare the efficacies of EP and AP in improving the bioavailability of phytate-P to weaning pigs in singular form and in combination with each other or with cereal phytase. In Exp. 1, 21 pigs (5-wk old, 8.11 ± .87 kg BW) were fed a corn-soybean meal basal diet containing no inorganic P (CS) supplemented with 500 U of phytase/kg of diet from AP, EP, and AP:EP (1:1) for 4 wk. In Exp.2, 36 pigs (5-wk old, 8.25 ± .79 kg BW) were used to compare the efficacy of 200 and 400 U of EP/kg of corn-soy diet containing 7.5% wheat middlings (WM, 151 U of phytase/kg of diet) with that of WM + Pi (.1%), and CS + Pi (.2%). In Exp. 1, pigs receiving CS + EP or CS + AP:EP had higher ADG (576 and 553 g, $P \leq .05$ and .08, respectively) than the pigs receiving CS + AP (463 g) during the last week of the study. Plasma alkaline phosphatase activity (AKP) was 13% higher ($P \leq .03$) in pigs fed CS + AP than those fed CS + EP diet at wk 1, and the difference became marginal at wk 4 (8%, $P \leq .07$). However, there was no difference in AKP between pigs fed CS + AP:EP and the other diets. In Exp. 2., pigs fed the CS + Pi had higher ($P \leq .05$) ADG than the other treatment groups. Increasing EP from 200 to 400 U/kg of diet resulted in 9% higher ($P \leq .05$) plasma inorganic P concentrations at wk 2 and 3. Pigs fed the higher level of EP had plasma inorganic P concentrations similar to those of pigs fed inorganic P-supplemented diets at wk 4. In conclusion, both new phytases were effective in improving phytate-P bioavailability to young pigs, but no significantly synergistic effect was seen with the combination of AP and EP, or with EP + cereal phytase under the current dietary conditions.

Key Words: Phytase, *Aspergillus fumigatus*, *Escherichia coli*

445 Effect of photoperiod on performance and energy metabolism of weanling pigs. E.M.A.M. Bruininx¹, C.M.C. van der Peet¹, W.J.J. Gerrits*², and J.W. Schrama², ¹Research Institute for Animal Husbandry, ²Wageningen Institute of Animal Sciences.

Feed intake is an important determinant of performance that may also reflect the health status of weanling pigs. Previous studies have suggested that illumination stimulates the early development of post weaning feed intake. In a 2-wk experiment the effect of photoperiod on performance and energy metabolism of newly weaned pigs was studied. Forty 4-wk-old crossbred weanling barrows weighing 8.0 kg (SEM = 0.13) were assigned to 8 groups of 5 pigs each based on BW and litter. Groups were allotted to one of two lighting schedules: 8 h light:16 h darkness or 23 h light:1 h darkness. Each group was housed in a climate respiration chamber. Piglets had ad libitum access to feed and water. Energy and nitrogen balances, heat production, ADFI and ADG were measured weekly. Heat production, energy metabolism and performance were unaffected ($P > 0.1$) by photoperiod during wk 1. However, in the second week ADFI (420 vs. 304 g/d) and ADG (381 vs. 240 g/d) were

higher ($P < 0.05$) for pigs at the 23:1 h lighting schedule than at the 8:16 h schedule. Furthermore, total energy retention, energy retained as protein and as fat were higher ($P < 0.05$) during week 2 in pigs at the 23:1 h lighting schedule (+131, +41, and +414% respectively) than at the 8:16 h schedule. Moreover, during wk 2 metabolizability of energy tended to be higher ($P < 0.1$) and energy requirements for maintenance were lower ($P < 0.05$) for pigs at the 23:1 h schedule compared with the 8:16 h schedule ($P < 0.1$). Heat production was unaffected by photoperiod during wk 2. In conclusion, exposing pigs to a longer period of light post-weaning stimulated ADFI and ADG. In addition to the feed intake, the high ADG is due to an improved metabolizability of energy and a reduced energy requirement for maintenance. The results from this study suggest that lighting schedule can be used as a tool to stimulate feed intake post weaning.

Key Words: Photoperiod, Metabolism, Pigs

446 Diets containing high quality animal proteins increase growth of early-weaned pigs. F. R. Dunshea*, P. J. Eason, D. J. Kerton, and T. Moyes, Agriculture Victoria, Victorian Institute of Animal Science, Werribee, Australia.

This study was conducted to compare the performance of early weaned pigs fed diets containing freeze dried bovine colostrum and porcine plasma with that of pigs fed diets containing conventional protein sources. Four male pigs per sow were weaned at 14 d of age from 24 sows and randomly allocated to one of four diets formulated to contain 15.5 MJ DE/kg, 0.95 g available lysine/MJ DE and 23.8% CP. All diets contained fishmeal (10%) and bloodmeal (3%) with the remaining supplemental protein being provided as skim milk (animal protein (A)), skim milk and soyabean meal (7%) (vegetable protein (V)), skim milk and plasma meal (plasma (P)) and skim milk and colostrum (colostrum (C)) The inclusion level of colostrum and plasma were reduced from 6 to 2.5% after 1 wk. Pigs fed P and C diets grew more quickly than pigs fed diets containing more conventional ingredients. However, the performance of pigs fed the A diet was only marginally less than the performance of pigs fed the diets containing immunoglobulins (Ig, C and P). Pigs fed the V diet ate less and grew more slowly than pigs fed any of the other diets, particularly over the first 2 wks after weaning. These data demonstrate that pigs fed bovine colostrum perform similarly to pigs fed freeze dried porcine plasma. While there was little benefit of feeding complex protein sources over feeding a predominantly animal protein diet, inclusion of even a moderate level of soyabean meal in the diet of early weaned pigs reduced performance over the first 2 wks post-weaning. Supported by the Pig Research and Development Corporation.

Age	Dietary A	Treatment V	Within C	IG vs P	Within sed	IG vs non-Ig	Within non-Ig	V vs non-V	
Daily Gain (g/day)									
14-21d	63	14	65	87	13	0.055	0.017	0.47	0.002
21-28d	247	205	270	233	22	0.049	0.11	0.26	0.016
28-35d	403	414	415	423	30	0.90	0.62	0.79	0.98
Feed Intake (g/day)									
14-21d	128	92	134	142	13	0.032	0.002	0.56	<0.001
21-28d	280	237	305	300	22	0.15	0.006	0.49	0.002
28-35d	480	466	491	503	32	0.83	0.30	0.78	0.33

Key Words: Pigs, Early-weaned, Protein

447 Potential for egg protein as a protein source for phase 1 nursery diets. J. F. Jaen*¹, C. V. Maxwell¹, Z. B. Johnson¹, D. C. Brown¹, S. Singh¹, M. E. Davis¹, K. J. Touchette², J. A. Coalson², and R. E. Musser³, ¹University of Arkansas, Fayetteville, ²Merrick's, Inc., Middleton, WI, ³The Pork Group, Inc., Rogers, AR.

An off-site trial using 216 weanling barrows was conducted to determine the efficacy of pasteurized (60°C for 1 hr) or non-pasteurized egg product to replace spray dried plasma (SDP) in the phase 1 (d 0 to 10) diet of nursery pigs. Pigs (The Pork Group, Inc.; 20 ± 2 d of age; 5.6 kg BW) were assigned by initial weight to one of six treatments in a randomized complete block designed experiment. There were six blocks with six pigs/pen. Six diets were fed during phase 1: 1) a negative control diet devoid of egg product and SDP, 2) a positive control diet containing 5% SDP added at expense of soybean meal 48%, 3) as 2 with pasteurized egg product replacing 50% of the SDP, 4) as 2 with pasteurized

egg product replacing 100% of SDP, 5) as 2 with non-pasteurized egg product replacing 50% of SDP, 6) as 2 with non-pasteurized egg product replacing 100% of SDP. All diets were formulated to contain 1.5% lysine. Upon completion of the phase 1 diet, a common phase 2 diet (1.35% lysine) was fed from d 10 to 24 after weaning, and upon completion of phase 2, a common phase 3 diet (1.20% lysine) was fed from d 24 to 38 after weaning. In phase 1, source of egg product (pasteurized or non-pasteurized) had no effect on ADG ($P > 0.1$). However, egg product added at the 50% inclusion level resulted in greater ADG and ADFI than when supplemented at the 100% inclusion level (158 and 241 vs. 134 and 189 g/d, respectively; $P < 0.05$). Pigs fed non-pasteurized egg product had greater G:F than pigs fed pasteurized egg product (0.763 vs. 0.637, respectively; $P < 0.05$). The results of this experiment indicate that non-pasteurized egg product can successfully replace 50% of SDP in nursery diets when SDP was included at 5%.

Key Words: Egg product, Diet, Nursery pigs

448 Performance of growing pigs fed wheat-based diets added with low levels of inorganic phosphorus. M. Cervantes*, A.B. Araiza, N. Torrentera, S. Espinoza, and M. Cervantes, *Universidad Autnoma de Baja California, Mexicali, Mxico.*

An experiment was conducted to evaluate the performance of growing pigs fed wheat-based diets, added with low levels of inorganic phosphorus (P). Thirty crossbred (Landrace x Yorkshire x Duroc) pigs (27.2 kg initial body weight) were assigned to 5 dietary treatments according to a randomized complete block design. Treatments T1, T2, T3, and T4 were wheat-based diets added with .20, .50, .70, and .90% dicalcium phosphate (DP), respectively; T5 was a wheat-soybean meal, control diet, formulated to meet the requirement of total P for the 20-50 kg pigs. Wheat was the sole source of dietary protein, energy, and organic P in the test diets. Inorganic P in the test diets was provided as dicalcium phosphate. Organic (wheat and soybean meal) and inorganic P were assumed to be 50, 23, and 100% available, respectively. Diets were formulated to contain .22, .28, .31, .35, and .43% available P. Feed and water were provided ad libitum. Regression analysis including treatments T1 to T4 were performed; also, the positive control was contrasted against the average of treatments T1 to T4. Daily weight gain, feed intake, feed/gain ratio, and intakes of lysine, threonine, total P, and available P were: 842, 884, 836, 878, 856 g/d; 1.93, 1.94, 1.87, 1.94, 1.76 kg/d; 2.68, 2.66, 2.6, 2.57, 2.31; 16.0, 16.1, 15.5, 16.1, 15.2 g/d; 9.7, 9.7, 9.3, 9.7, 10.9 g/d; 7.9, 9.1, 9.3, 10.5, 8.6 g/d; 4.2, 5.4, 5.8, 8.8, 7.6 g/d. Intake of both total and available P increased ($P < .01$) as the supplementation level of inorganic P increased. However, none of the performance variables (daily gain, feed intake, feed/gain ratio) was affected ($P > .10$) by the supplementation level of inorganic P. The supplementation level of inorganic P did not affect either lysine or threonine intakes. These data indicate that organic P from wheat can replace significant amounts of P from inorganic sources, reducing the cost of the diet and the P pollution. These results also show that formulating diets on the basis of available P reduce the need for inorganic P without affecting pig performance.

Key Words: Pigs, Wheat, Available phosphorus

449 Growth performance and carcass characteristics of grow-finish pigs fed increasing levels of distiller's dried grains with solubles. M. H. Whitney*¹, G. C. Shurson¹, L. J. Johnston², D. Wulf³, and B. Shanks³, ¹University of Minnesota, St. Paul, MN, ²University of Minnesota, Morris, MN, ³South Dakota State University, Brookings, SD.

Currently, the recommended maximum inclusion rate of distiller's dried grains with solubles (DDGS) in grow-finish swine diets is 10%. However, previous studies conducted at the University of Minnesota have shown that DDGS produced from new ethanol plants in the MN-SD region has higher nutrient levels and digestibility than reported in NRC (1998). Therefore, we conducted a growth performance and carcass evaluation study to re-evaluate the recommended maximum inclusion rate of DDGS in grow-finish diets when formulated on a total amino acid basis. A total of 240 (28.4 ± .8 kg) crossbred pigs were randomly assigned to one of 4 dietary treatment sequences in a 5-phase grow-finish feeding program (24 pens, 10 pigs/pen, 6 reps/trt). Dietary treatments consisted of corn-soybean meal diets containing 0, 10, 20, or 30% DDGS. All diets were formulated to contain equivalent total lysine, ME, Ca, and P levels

within each phase. Pigs were weighed and feed disappearance was determined bi-weekly. Time of changing to the subsequent diet phase was based on average pen weight within dietary treatment sequence. Pigs were slaughtered and carcass data collected when average pen weight reached 115 kg. Pigs fed the 20 or 30% DDGS diets had reduced ADG ($P < .10$) compared to 0 or 10% DDGS, but ADFI was unaffected by dietary treatment ($P > .10$). Feed/gain increased when pigs were fed 30% DDGS ($P < .10$) compared to 0, 10, and 20% DDGS inclusion levels. Dressing % decreased linearly ($P < .03$) with increasing dietary DDGS level, but slaughter weight was also lower for pigs fed 20 or 30% DDGS ($P < .05$). Loin depth was lower in pigs fed the 30% DDGS diets ($P < .10$), but backfat depth and % lean did not differ between treatments ($P > .10$). Results from this study suggest that when grow-finish diets are formulated on a total amino acid basis, less than 20% DDGS should be included in the diet for optimal performance and carcass composition. Dietary inclusion levels of 20% or greater may provide satisfactory performance and carcass composition if diets are formulated on a digestible amino acid basis.

Key Words: Pigs, Distiller's Dried Grains with Solubles, Growth

450 Availability of phosphorus in distiller's dried grains with solubles for growing swine. M. H. Whitney* and G. C. Shurson, *University of Minnesota, St. Paul, MN.*

A total of 42 growing barrows (20.1 ± 1.3 kg initial BW) were used in a slope-ratio assay to determine the availability of P in distiller's dried grains with solubles (DDGS) produced from ethanol plants in the MN-SD region. Barrows were randomly allotted by weight and ancestry to one of seven dietary treatments. Pigs were housed in individual metabolism cages and fed either a corn starch-soybean meal control diet (.29% total P) or one of six diets containing increasing levels of total P from either dicalcium phosphate (DCP) or DDGS (.34, .39, and .44% total P). Pigs were fed at a level equivalent to 2% of their initial body wt twice daily, and were allowed a 7 d adjustment period prior to a 5 day collection period. Total feces and urine were collected for each pig and analyzed for total P. Phosphorus retention was calculated as the difference between P intake and excretion. Actual P intake ranged from 2.33 g/d (control diet) to 3.91 g/d (DDGS diet with .44% total P). Urinary and fecal P excreted and total P retained increased linearly ($P < .01$) with increasing P intake, regardless of P source. However, P retention (% of intake) was not different between dietary treatments ($P > .10$). A linear regression analysis was conducted for P excreted and P retained relative to P intake for each dietary treatment separately. The slope ratios of the regression lines from each P source were used to determine P availability. Availability of P in DCP was assumed to be 100%. Slopes for P excreted and retained were .354 and .646 (DCP, $R^2 = .42$ and $.72$) and .405 and .595 (DDGS, $R^2 = .55$ and $.73$), respectively. Availability of P was 87.5 % and 92.2 %, based on P excretion and P retention, respectively. These results suggest that DDGS from the MN-SD region is an excellent source of available P for growing swine, and that P availability is higher than listed in NRC (1998).

Key Words: Pigs, Distiller's Dried Grains with Solubles, Available Phosphorus

451 Feeding value of hullless and hulled barley in grower pig diets. A.N. Fenton*, J.S. Radcliffe, A.F. Harper, M.J. Estienne, D.E. Brann, and C.A. Griffey, *Virginia Polytechnic Institute and State University.*

Ninety-six crossbred pigs (initial BW=38kg) were used in a 6-wk experiment to investigate the feeding value of hulled or hullless barley in pelleted grower pig diets. Pigs were randomly allotted to four dietary treatments, with six replicate pens of each. Diets 1, 2 and 3 were formulated to contain 0.95% Lys, 0.23% available P, 0.60% Ca and 3,446 kcal/kg DE. Diet 1 was corn-soybean meal (SBM) based. Diets 2 and 3 contained 25% corn and a combination of SBM and 46% hullless barley (Diet 2) or 42% hulled barley (Diet 3). Diet 4 was identical to Diet 2 except hulled barley replaced hullless barley on an equal weight basis. Therefore, this diet was lower in CP, energy and mineral content. Pigs had ad libitum access to feed and water. Individual BW and pen feed consumption were recorded weekly. During wk-6, fresh fecal samples were collected six times from at least three out of the four pigs in each pen. Fecal and feed samples were analyzed for Ca, P, Cr, N, DM and energy. The Duncan procedure of SAS (1994) was used to compare treatment means, with pen serving as the experimental unit. Diet type

had no effect ($P>0.10$) on ADG or feed intake over the 6-wk experiment. However, due to numerical differences in feed intake and ADG, feed efficiency was improved ($P<0.05$) for pigs fed Diet 3. There was no effect ($P>0.10$) of diet type on Ca digestibility. Phosphorus, DM, CP and energy digestibilities were lowest ($P<0.05$) for pigs fed Diet 4. The digestibility of P was similar for pigs fed Diets 1, 2 and 3. Pigs fed Diet 2 had a higher DM digestibility compared to pigs fed Diet 1 ($P<0.05$), but were similar to those fed Diet 3. Pigs fed Diet 3 had a higher CP digestibility than those fed Diets 1 or 2 ($P<0.05$). However, pigs fed Diet 3 had a slightly lower energy digestibility than pigs fed Diets 1 or 2 ($P<0.05$). The results of this study indicate that hullless or hulled barley can be incorporated into swine diets at levels of at least 40% and yield performance similar to corn-SBM based diets, if diets are formulated to the same nutrient specifications.

Key Words: Pig, Barley, Digestibility

452 Energy and nitrogen balance of pigs fed four corn grains. R.W. Fent*, S.D. Carter, M.J. Rincker, and B.W. Senne, *Oklahoma State University, Stillwater.*

Six sets of four littermate barrows (27.5 kg) were used to evaluate four corn grains (A, B, C, and D) in an energy and nitrogen balance experiment. Corns A and B were nearly isogenic with A being normal corn, while B was a high-oil variety. Corns C and D were also normal varieties. Pigs were housed individually and allotted to four dietary treatments based on weight and litter. Experimental diets (1.0% Lys) consisted of corns A, B, C, or D (90.48%) with casein (5.04%), crystalline amino acids, and a vitamin/mineral source. Pigs had ad libitum access to water and an effort was made to equalize feed intake within replicate. A 7-d adjustment period to the diets was followed by a 5-d collection of feces and urine. Data are reported on a DM basis unless otherwise noted. GE concentration and CP content of corns A, B, C, and D were: 4,462, 4,761, 4,594, and 4,601 kcal/kg and 8.73, 9.14, 9.47, and 9.02%, respectively. GE intakes for pigs fed diets containing A, B, C, and D were 5,452, 5,291, 5,387, and 4,965 kcal/d. However, fecal and urine GE excretions (kcal/d) were similar ($P>0.10$) across all treatments. The DE for the diets containing A, B, C, and D were 3,924, 4,186, 4,061, and 3,990 kcal/kg while ME were 3,868, 4,127, 4,006, and 3,935 kcal/kg, both varying ($P<0.04$) depending on source of corn. However, no differences ($P>0.10$) were seen in DE:GE (.886, .887, .894, and .885) or ME:GE (.874, .875, .882, and .873). Nitrogen absorption and retention were not affected by corn source. Previously, we determined the ME

of casein to be 4,560 kcal/kg and, thus, the casein in the diet (5.04%) supplied 230 kcal/kg. Subtraction of the ME provided by casein from the ME of the diets resulted in ME concentrations of 3,600, 3,842, 3,660, and 3,625 kcal/kg (as-fed basis) for corns A, B, C, and D. This correction resulted in slight differences ($P<0.10$) in ME:GE (.901, .905, .909, and .890) for the corn grains. These results indicate that although ME concentrations varied for the four corn grains, the differences observed were attributed to initial variation in GE concentration.

Key Words: Corn, Metabolizable energy, Pigs

453 Swine digestible energy evaluations of Bt (MON810) and Roundup Ready® corn compared with commercial varieties. A.M. Gaines*, G.L. Allee, and B.W. Ratliff, *University of Missouri-Columbia.*

Two digestible energy experiments were conducted to compare nutritional value of insect protected (containing CryIA (b) protein, Bt) corn, glyphosate-tolerant (Roundup Ready, RR) corn (containing maize EP-SPS protein), their near-isogenic parents (BtC and RRC) and three commercial corn hybrids (C1, C2, and C3). Twenty crossbred barrows (26.4±2.8 kg) were placed in metabolism crates allowing for separate collection of feces in two collection periods. Pigs were assigned to one of the five dietary treatments in a complete randomized design. Fecal matter was collected and feed disappearance recorded for the five-day periods. Both fecal material and feed were analyzed for dry matter and gross energy values to determine digestible energy coefficients for each of the experimental hybrids. There were significant differences ($P<0.05$) in digestibility coefficients (88.1%, 87.7%, 86.2%, 87.3%, and 87.6% for Bt, BtC, C1, C2, and C3, respectively). However, Bt was not different than its near-isogenic parent (BtC). Twenty additional crossbred barrows (25.5±2.9 kg) were placed in metabolism crates in two collection periods and assigned to one of the five dietary treatments in a complete randomized design. Fecal matter was collected and feed disappearance recorded for the five-day periods. There were significant differences ($P<0.05$) in digestible energy coefficients (87.3%, 88.4%, 86.0%, 88.6%, and 88.0% for RR, RRC, C1, C2, and C3, respectively). However, RR was not different from its near-isogenic parent (RRC). In conclusion, Bt and RR corn digestible energy coefficients values are not different from their near isogenic parents; however, there were differences among the other three commercial corn hybrids tested.

Key Words: Corn, Energy, Swine

ASAS/ADSA Breeding and Genetics: Quantitative Methods

454 Use of matrix exponentials to enforce the positive definite constraint of covariance matrices. S.D. Kachman*, *University of Nebraska.*

Restricted maximum likelihood estimates of covariance matrices must be positive definite. Enforcing the positive definite constraint for unstructured covariance matrices is a challenge. Matrix exponentials provide a means of reducing the positive definite constraint to a symmetry constraint. An unstructured covariance matrix \mathbf{V} can be written as the exponential of a matrix \mathbf{A} . A matrix exponential is defined as $\mathbf{V}=\exp(\mathbf{A})=\sum_{i=1}^{\infty} \frac{\mathbf{A}^i}{i!}$. Provided that \mathbf{A} is symmetric and finite the covariance matrix $\mathbf{V}=\exp(\mathbf{A})$ is positive definite. By taking a spectral decomposition of $\mathbf{A}=\mathbf{P}\mathbf{D}\mathbf{P}'$ and iterating on \mathbf{D} as opposed to \mathbf{A} , the required derivatives are dramatically simplified. The partial derivative of \mathbf{V} with respect to δ_{ij} , element ij of \mathbf{D} , is $\mathbf{P}\Delta_{ij}\mathbf{P}'$ where Δ_{ij} is matrix of zeros except for elements ij and ji which are equal to $[\exp(\delta_{ii})-\exp(\delta_{jj})]/[\delta_{ii}-\delta_{jj}]$. The derivative reduces to $\exp(\delta)$ when $\delta_{ii}=\delta_{jj}=\delta$.

Key Words: Mixed Model, REML

455 Use of partial augmentation to improve the Monte Carlo sampling of variance components. R.A.A. Torres Jr and Richard L. Quaas, *Animal Science Department - Cornell University.*

The use of Gibbs Sampling (GS) to estimate variance components (Σ) for some highly parameterized mixed linear models (animal models) results in chains with very slow mixing. Sampling all location parameters (θ) together may not be enough to overcome the slow mixing. Procedures to sample from the marginal distribution of dispersion parameters have

been suggested but they can be too computationally burdensome for certain applications. Sampling from the marginal distribution of variance components involves evaluating the likelihood as in derivative-free REML estimation, where the determinant of the mixed model equations is obtained using factorization techniques for sparse matrices. This factorization involves reordering the system of equations and results in an arrow shaped system (\mathbf{C}). This shape is the useful feature exploited here. The upper left-hand block (\mathbf{C}_{11}), corresponding to the tail of the arrow, is usually very large and very sparse and its determinant can be computed at a much lower cost than that for the entire system. Our approach is to sample Σ from its distribution marginal with respect to location parameters at the tail of the arrow (θ_1), but conditional to those at the head of the arrow (θ_2). To do so, we compute $\pi(\Sigma-\theta_2, \mathbf{y})$ which is proportional to the target distribution and requires the Cholesky factor of \mathbf{C}_{11} only and use it in a Metropolis-Hastings (MH) algorithm to obtain a sample of Σ . For a system of 255,325 equations, 75,699 were avoided by combining additive and cow effects for non-parents, what is possible as we use MH for sampling Σ . \mathbf{C}_{11} was assigned 168,000 equations as a high increase in computation resulted if more equations were included. This resulted in augmenting only with 11,626 parameters, which is about 4.5% of the number of augmented parameters in the usual implementation of the GS. Such approach is a compromise between marginal sampling and full conditional sampling of dispersion parameters. It is capitalizes on the shorter chain needed with full conditional sampling (lower autocorrelations) and the computational ease of marginalization.

Key Words: Markov Chain Monte Carlo, Covariance function, Test-day model

456 Least Squares Lehmann-Scheffe superior to other methods for estimating variance components and heritability. W.D. Slinger* and J.W. Carlson, *North Dakota State University*.

Least Squares Lehmann-Scheffe (LSLS) estimators (Slinger, 1996) of two variance components and heritability were compared with those of ANOVA (=Henderson's Method 3 (H3)), MINQUE, ML, and REML. Model was fixed herd by random sire with interaction. Thirty-nine progeny were distributed over 3 herds and 4 sires. There were 15,000 computer simulation replications per each of 96 combinations of designs ($n=6$), heritabilities (.05, .20, .50, .70), ratios of sire variance to interaction variance (3:1, 1:3), and distributions (normal and chi-square with 3 df). The designs ranged from almost balanced to very unbalanced. Nonzero estimates of variance components and heritability were used in the comparisons presented here. Results for the normal distribution are presented here since normal and chi-square results were approximately the same for all 96 combinations. LSLS was superior to the other four methods, and the more unbalanced the design the more superior was LSLS. For instance, the relative mean square errors for heritability estimators averaged over the 48 combinations were 1.0, 2.7, 2.4, 2.2, and 2.8 for LSLS, H3, MINQUE, ML, and REML, respectively. The analogous percentages of nonzero estimates of heritability were 44, 29, 28, 17, and 28%. For the most unbalanced design, the relative mean square errors for sire variance estimators averaged over the eight combinations were 1.0, 7.6, 9.5, 4.3, and 7.3, for LSLS, H3, MINQUE, ML, and REML, respectively. The analogous percentages of nonzero estimates of sire variance were 67, 64, 61, 40, and 51%. Distributions of all LSLS estimators were superior in that the percentages of estimates within plus and minus 50% of the value of the parameter were almost always greater for LSLS than all other methods. Estimator performances were approximately the same whether the variance ratio was 3:1 or 1:3. Results are substantive evidence that LSLS is superior to the compared methods for estimating variance components and heritability and justify efforts to make the procedure computationally efficient.

Key Words: Estimation, Variance components, Heritability

457 Correlations between clinical mastitis at different stages of lactation in Norwegian Cattle using a multivariate threshold model. Y. M. Chang*¹, R. Rekaya², D. Gianola¹, B. Heringstad³, and G. Klemetsdal³, ¹*Department of Animal Sciences, University of Wisconsin, Madison*, ²*Department of Dairy Science, University of Wisconsin, Madison*, ³*Department of Animal Science, Agricultural University of Norway*.

Clinical mastitis records on 13,070 first-lactation cows from 1,868 herds, progeny of 250 sires, were analyzed. The interval ranging from 30 days pre-calving to 150 days post-partum was divided into 6 periods of equal length. Within period, it was checked whether mastitis occurred or not. Mastitis incidence was 4.3% and 10.6% in the first two periods, and ranged between 1.9% and 2.1% subsequently. The objective was to infer genetic and residual correlations between mastitis in the 6 periods. An hexivariate analysis was carried out with a Bayesian threshold model, assuming that mastitis (presence vs. absence) was a different trait in each period. Using a multivariate normal link, unobserved mean liabilities were modeled as a linear function of year, age-season of calving, herd, and sire effects. All residual variances were set equal to one. For cows culled before 150 days, missing liabilities were included in an augmented posterior distribution. Gibbs sampling was used to draw from posterior distributions of interest, and an algorithm was devised to collect samples from the residual correlation (covariance) matrix. Heritability of clinical mastitis was 0.12, 0.09, 0.11, 0.09, 0.08 and 0.09 for the 6 periods. Genetic correlations were positive and small (0.03 ± 0.27), except between periods 1 and 3 (-0.07) and periods 1 and 6 (-0.18). Most posterior coefficient of variations were larger than 100%, and zero was included in 95% credibility sets for all genetic correlations, illustrating lack of precision of inferences. Results may suggest that different genes are involved in the expression of clinical mastitis in different periods. Residual correlations ranged between -0.11 and 0.44, and were smaller for non-adjacent intervals.

Key Words: Clinical mastitis, Heritability, Threshold model

458 An assessment of threshold models with Student *t* distributed liabilities for the analysis of calving ease. K. Kizilkaya*¹, P. Carnier², G. Bittante², A. Albera³, and R. Tempelman¹, ¹*Michigan State University, East Lansing, MI, USA*, ²*University of Padova, Legnaro, Italy*, ³*Associazione Nazionale Allevatori Bovini di Razza Piemontese, Carru, Italy*.

A heavy-tailed Student *t* residual distribution may be specified as an alternative to the Gaussian distribution for the conceptual underlying liability variables in a regular threshold model. This threshold-*t* model specification is an attempt to confer outlier-robustness properties for the analysis of ordered categorical data, e.g. calving ease. However, it is not known how well various Bayesian model choice criteria would be able to correctly discern between a threshold-*t* and a regular threshold model specification in animal breeding and what implications model choice might have on breeding value inference. We assess these issues using MCMC methods in a simulation study and in an application to calving ease data. For each of three populations, underlying liabilities were generated for 1000 progeny from 50 sires, with each sire mated to 5 dams. Each population was characterized by a residual scale (variance) parameter of 1.00 and a genetic variance of 0.50 for normally distributed genetic effects. The residual effects were Student *t* distributed with degrees of freedom being 4, 20, or infinity (i.e. Gaussian) for the three populations, respectively. Underlying liabilities were converted to ordinal data with four categories based on the same threshold parameter values (relative to the overall mean) of -0.25, 0.25 and 1.25 for all populations. The data was analyzed using threshold animal models with either normal or Student *t* distributed residual specifications on the liability scale. Model choice, as based on various pseudo-Bayes factor criteria, was correctly assigned in all three cases. The regular threshold and threshold-*t* sire maternal-grandsire models were also applied to data on calving ease scores in Italian Piedmontese cattle. The Bayes factor criteria (>100) appeared to heavily favor a threshold-*t* specification; nevertheless, the rank correlation on posterior means of breeding values between a threshold-*t* and regular threshold model analyses exceeded 0.98.

Key Words: Threshold Model, Model Choice

459 Bayesian inference in linear mixed model using Dirichlet process prior. Romdhane Rekaya*, *Dept. of Dairy Science, University of Wisconsin*.

Practice of hierarchical modeling has exploded in the last decade both in applied statistics and in animal breeding. Such explosion is a result of 1) the great capacity of hierarchical modeling in solving complex problems by breaking them into submodels (parts) that can be solved more easily and then assembled in a natural way and 2) the development of Markov Chain Monte Carlo methods (MCMC) to overcome the computational complexity. In hierarchical models, as with all parametric models, specification of distributions for parameters and often hyperparameters is required. Usually a considerable uncertainty is associated with those distributions leading to inevitable concerns about the sensitivity of the resulting inferences to the assumed forms of component distributions. Hence, a nonparametric or semi-parametric modeling that avoids the prior specification of distribution forms is a logical choice to assess such uncertainty. A nonparametric model using Dirichlet process prior was implemented for a small data set to assess the sensibility of assuming normality for the distribution of the additive breeding values. 5621 first lactation milk yield records and 7094 animals in the pedigree were used to compare a nonparametric hierarchical model with a standard mixed linear model. Posterior mean of heritability was 0.32 and 0.31 using standard mixed linear model and nonparametric hierarchical model, respectively. No significant differences were observed on the posterior means of the genetic and residual variances using both models. The posterior mean of the "degree of belief" or precision parameter on the baseline prior of the distribution of additive breeding values was 13 strongly supporting the normality of such distribution. In animal breeding applications using mixed linear model, it looks more reasonable to assume uncertainty over the distribution of the error terms given the possibility of outlying observations.

Key Words: nonparametric, Dirichlet, Bayesian

460 Bayesian analysis of skewed Gaussian models: an application to reproductive traits in dairy cattle. G. J. M. Rosa^{*1,2}, R. Sartori², M. C. Wiltbank², and D. Gianola², ¹UNESP - Botucatu, SP/Brazil, ²UW - Madison, WI.

A normal distribution is assumed often in statistical analysis. If the assumption does not hold, e.g., when data are skewed, Gaussian-based methods may lead to erroneous inference. Alternatives include data transformations, non-parametric methods or assumptions meeting the skewness requirement. Here, the approach of Fernández and Steel (*JASA* **93**: 359-371, 1998) was adopted for modeling skewed Gaussian distributions. An extra parameter, controlling allocation of mass to both sides of the mode, is required. Data were from an experiment with Holstein cows aimed to study whether or not high milk yield affects embryo quality. Twenty-seven dry and 28 lactating cows (40-100 days post-partum) were synchronized and bred by AI. Five days after insemination, embryos were evaluated for embryonic cell nuclei cycles (ECC, estimated from embryonic cell counts) and number of accessory sperm (NAS). A Bayesian framework (with diffuse priors) was adopted; a Gibbs sampler with Metropolis-Hastings steps was used to carry out the analyses. Gaussian and skewed models with different assumptions about homogeneity of scale and skewness parameters were compared using Bayes factors. Single chains were run for each model, with 300,000 iterations for posterior inferences, after burn-in. There was skewness to the left and to the right, respectively, of the distributions of ECC and of NAS. Bayes factors gave stronger support to models having a homogeneous scale parameter, but different skewness parameters for the two groups, for both traits. No differences were found for NAS between groups of cows. ECC was more skewed in lactating cows, as some embryos had very few cycles. The skewed Gaussian methodology offers a flexible alternative for analysis of biological data.

Key Words: Skewed distribution, Bayesian inference, Reproductive traits

461 Bayesian inference on uncertain paternity for prediction of genetic merit. F. F. Cardoso^{*} and R. J. Tempelman, *Michigan State University, East Lansing, MI/US.*

A simulation study was used to compare the performance of three different genetic evaluation methods when 30% of non-parent animals (i.e. without progeny) have uncertain paternity due to the use of multiple sires in mating groups. One method was best linear unbiased prediction based on Henderson's average numerator relationship matrix (ANRM). The other two methods were Bayesian and used the data to infer upon the probability of an individual with uncertain paternity being sired by any one of a number (2, 3, or 4) of candidate sires. One of these methods was an empirical Bayes (EBAYES) procedure and the other was a fully Bayesian procedure based on the use of Gibbs sampling (GIBBS). Ten simulated populations were generated at each of three different levels of heritability (h^2): .10, .30 and .50. Each population consisted of four generations of phenotypic selection and included 20 sires, 100 dams and 500 non-parent animals in total. The methods were compared by mean squared error of prediction (MSEP), mean bias (MBIAS) and rank correlation (RANK) between estimated and true breeding values. Mean posterior probabilities of true sires (MPPTS) for individuals with uncertain paternity were generally of similar magnitude under EBAYES and GIBBS. For either Bayesian method, the MPPTS were significantly greater ($P < .05$) than the corresponding prior probabilities (inverse of number of candidate sires) at h^2 equal to .30 and .50; however, these differences were not very large (+3.1 to +7.1%). At h^2 equal to .10, the MPPTS were generally not different from the prior probabilities ($P > .05$). There were no significant differences in genetic evaluations between the three methods in terms of MSEP, MBIAS and RANK ($P > .05$) for all three heritabilities. These results indicate that there may be little power in field data to infer upon candidate sire assignments for individuals with uncertain paternity. Under these and similar situations, ANRM may be satisfactorily used for genetic evaluations, particularly in light of the savings in computing resources compared to EBAYES and GIBBS methods.

Key Words: Multiple sires, Genetic evaluation, Gibbs sampling

462 Two-step and random regression analyses of weight gain of Canadian beef bulls. Flavio Schenkel^{*}, Stephen Miller, Janusz Jamrozik, and James Wilton, *University of Guelph, Guelph, ON, Canada.*

Objective was to compare a two-step (TS) model and a joint procedure via random regression model (RR) for evaluating weight gain of 25,315 bulls, weighed every 28 days on 140 day test. TS analysis consisted of fitting fixed linear regressions to weights of each bull on days of measurement to determine gain on test. In the second step, mixed model analyses of gain estimated variance components and breeding values (EBV), including fixed effects of breed, test group and starting age, and random effects of weaning herd-year group (WHY) and of animal (additive genetic). The RR model included the same effects as the TS mixed model analyses, with additional random animal permanent environment (PE) effect. Fourth order Legendre polynomials of days on test were fitted for all fixed and random effects in the model, except for breed. Breed effects and residual variances were estimated for each measurement period. Variance components and EBV's for gain were obtained from the estimated covariance function and random regression coefficients for weight. RR heritability (h^2) estimates for gain on test increased over time, being maximum at end of test (0.377) and similar to TS procedure (0.376). PE variance ratio estimates also increased over time and were higher than h^2 . WHY variance ratio estimates kept constant over time, being slightly higher at end of test (0.076) than TS (0.069). Genetic correlations between gain up to different days on test given by RR were high (from 0.81, between 28 and 140 day gain on test, to 0.99, between 112 and 140 day gain on test). Genetic correlations between gain on discrete 28 day intervals were moderate to high (e.g., 0.53 and 0.86 between the last 28 days on test and the first and fourth 28 days, respectively). Rank correlation between EBV's for 140 day gain by the two procedures was 0.97, 0.83, and 0.67 for all bulls, the 5% best (highest RR EBV's), and the 1% best bulls, respectively. Results indicate that, despite similar h^2 estimates, the two procedures rank top bulls quite differently for 140 day gain on test. RR model accounted for changes over time of genetic and environmental effects on the test weight gain curve of the bulls.

Key Words: Weight Gain, Beef Cattle, Random Regression

463 Predictions of 305-day lactation yields in cows by ARMA models. N.P.P. Macciotta^{*1}, D. Vicario², G. Pulina¹, and a. Cappio-Borlino¹, ¹Universit di Sassari, Italia, ²Italian association of Simmental cows breeders .

This study deals with ARMA models, a family of stochastic models originally developed in the context of time series analysis, used to predict Test Day (TD) yields of milk production traits in dairy cows. The main feature of ARMA models is their ability to take account both of the average lactation curve of a homogeneous group of animals and of the residual individual variability that may be explained in terms of probability models, such as Autoregressive (AR) and Moving Average (MA) processes. Furthermore, the standard method of ARMA estimation includes several diagnostic tools such as Fourier transform, autocorrelation and partial autocorrelation functions, that are helpful in identifying the most appropriate model structure. Data were TD of milk production traits (milk, fat and protein yields) of 6,000 Italian Simmental cows, with 8 TD records per lactation. Homogeneous groups were formed according to parity (1st, 2nd and 3rd calving) and data were fitted to a Box-Jenkins ARMA model. Different situations of missing data were simulated and cumulated 305-d yields were calculated by TIM using all actual (actual yields) or actual plus forecasted (estimated yields) TD yields. Accuracy of predictions is remarkable also when a few actual TD records are available. As an example, in third parity cows the correlations between actual and estimated yields are 0.88 for milk and protein and 0.84 for fat when 6 out of 8 TD records are predicted. Accuracy rapidly increases with the number of actual TD available: correlations are about 0.96 for milk and protein and 0.93 for fat when 4 out of 8 TD records are predicted. In comparison with the standard method of projecting lactations in progress by extension factors, ARMA modelling do not compress the variance of predictions. Furthermore, ARMA models can be easily implemented in data recording softwares also at farm level.

Key Words: Milk Production Traits, ARMA Models, Test Day

464 Establish confidence intervals for daily milk yield measures by robust bootstrap. P. M. Saama*¹ and I. L. Mao², ¹Michigan State University, East Lansing, MI, ²National Institute of Agricultural Science, Denmark.

Prior to statistical analyses of daily milk yield data, outliers due to equipment malfunction or confirmed milk recording errors should be removed. However, those outliers that are caused by health status, body condition, stress, energy balance, or BST would be valid data. Hence, using the central limit theorem (CLT) to establish confidence intervals (CI) for yield measures could be misleading. The "ordinary" bootstrap performs poorly in these situations. This study demonstrates the use of a robust bootstrap resampling algorithm to construct CI for daily milk yield. The double bootstrap algorithm advances the notion that CI can be constructed from a function of the sample and the mean whose distribution is independent of the mean, the sample, or any other unknown parameter using pivotal quantities. In the algorithm, the mean of the data is computed. Then the first stage bootstrap sample (F) of size n is obtained from the observed data, with replacement (WR). The difference between the mean of F and the mean of the observed data is divided by the SE of the mean (SEM) of F, is a pivotal quantity that provides a robust bootstrap-t distribution of the mean daily yield. Then, the second stage bootstrap sample (G) of size n is randomly drawn WR from F. The difference between the mean of this bootstrap sample and the mean of F is now divided by the SEM of G. The first and second stage bootstraps are repeated B and K times, respectively. The CI for the mean can be obtained from the percentiles of the bootstrap distributions. Daily milk records for 89 first lactation cows from a Michigan herd were used for demonstration with B=500 and K=500. The distribution was skewed to the right at peak and in late lactation. The 95% CI given by the CLT were widest. The ordinary bootstrap gave narrow CI while the bootstrap-t and double bootstrap methods gave relatively stable CIs. After computing 99% confidence intervals using this approach, data that do not fall within the limits of that interval could be removed prior to statistical analysis.

Key Words: Milk yield, Variation, Bootstrap

465 Determination of covariance functions for lactation traits on dairy cattle using random-coefficient regressions on B-splines. R.A.A. Torres Jr and Richard L. Quaas, *Animal Science Department - Cornell University*.

Covariance functions for dairy cattle have been specified either by a multi-trait analysis of records within an interval of the lactation followed by extrapolation or by direct modeling of observations throughout the lactation using random-coefficient regressions. Here we present an approach using regressions on B-splines that is an extension of the within interval multi-trait analysis where the intervals are specified by the knots. It allows local fitting behavior and simultaneous modeling of every day of the lactation. The approach was applied to 296,601 test day records from 36,520 cows for milk yield, 180,474 records from 27,320 cows for fat and protein yield and 135,336 records from 26,628 cow for somatic cell score coming from 13 large dairy herds from New York State during 1989 through 1997. A longitudinal model with cows as subjects was used together with other effects to adjust for environmental effects and a heteroskedastic independent residual. Inferences about the dispersion parameters were made from the samples of a Markov Chain Monte

Carlo procedure. For milk yield the 3 largest eigenvalues of the covariance function for the cow specific effect accounted for at least 85%, 11% and 2.5% of the total variance and the respective eigenfunctions were close to constant, linear and quadratic functions, with slight discrepancy at the extremes causing variance reduction. For fat and protein yield the first eigenvalue accounted for at least 94.88% and 96.20% of the total variance, respectively. This shows that a repeatability model with heterogeneous variance to account for smaller variation, mostly at the beginning of the lactation, should suffice for these traits. Somatic cell score had at least 5 eigenvalues accounting for more than 1% of the total variance. For this trait too, the first 3 eigenfunctions closely followed the constant, linear and quadratic functions.

Key Words: Covariance functions, Test-day model, B-splines

466 Comparison of random regression test-day models using Bayes factors. Pedro Lopez-Romero*¹, Romdhane Rekaya², Yu-Mei Chang², Daniel Gianola², and Maria J. Carabao¹, ¹Departamento de Mejora Genética y Biotecnología. INIA. Madrid-Spain, ²Department of Animal Sciences. University of Wisconsin. Madison, WI- USA.

Test-day milk yields (TD) from Spanish Holstein cows were analysed with a set of random regression models (RR), including Wilmlink (W) and Ali-Schaeffer (A) functions, and Legendre polynomials (L) of varying order on additive (3 and 5) and permanent (3,5 and 6) effects. Data were 47,982 completed first lactations. L were selected from a previous study, where a wider range of L models was evaluated using REML, assuming constant residual variance (CRV). Model performance had been assessed via goodness of fit, predictive ability, and behaviour of estimated daily variance and of correlations involving yields at different parts of lactation. These RR were revisited from a Bayesian perspective, allowing for heterogeneous residual variance (HRV) between 3 intervals. Gibbs Sampling was used to draw from marginal posterior distributions. The log-marginal likelihood (LML) was estimated for each model using the harmonic mean of likelihood values. Estimated LMLs can be used to compute the Bayes Factors (LBF). LBFs were greater than 150 in all cases, showing a very strong evidence in the Jeffreys's scale. The A model did not reach the convergence after 460,000 iterations. L models reached the convergence very fast since orthogonal polynomials lower the correlation between samples. The most plausible specification was an L model of 3rd order for additive effects, and of 6th order for permanent effects. Further analysis was done for 3 L models of order 3 for additive 3,5 and 6 for permanent effects, assuming CRV. A better performance than for its corresponding HRV counterpart was noted for the 5th and 6th order models for permanent effect.

MODEL	LML ($\times 10^9$)	RV		
		5-75d	76-265d	266-335d
L(3,3)	-4.906	15.53	10.06	9.24
L(3,5)	-4.798	13.10	9.40	8.30
L(5,5)	-4.796	13.12	9.41	8.38
L(3,6)	-4.782	12.69	9.31	8.29
W	-5.663	21.94	17.11	28.07
L(3,3)	-4.912		10.96	
L(3,5)	-4.781		9.81	
L(3,6)	-4.770		9.58	

Key Words: Test day models, random regression, Bayes factor

ASAS/ADSA Food Safety: Microflora Surveillance

467 Effect of Shipping Stress in Beef Cattle on Prevalence Levels of Enterohemorrhagic E. coli and Salmonella spp. from the Feedlot to the Packing Plant. A.R. Barham¹, B.L. Barham*¹, A.K. Johnson¹, D.M. Allen², J.R. Blanton, Jr.¹, and M.F. Miller¹, ¹Texas Tech University, ²Excel Corporation.

Two hundred steers and heifers, from ten pens were used to determine prevalence of Enterohemorrhagic E. coli (EHEC) and Salmonella spp. (SAL) prior to and after shipping to a packing plant. Two samples were collected per animal: ventral midline hide swab and fecal sample, two weeks prior to transportation and at the packing plant. Samples were collected from all trucks before loading animals. EHEC and SAL tests were conducted following USDA & FSIS approved protocols.

Prevalence levels were generated using the frequency procedure in SAS (1995). Changes in prevalence levels were analyzed using the T-test procedure in SAS (1995). Overall prevalence of EHEC on hides and in feces at the feedlot were 18% and 9.5% respectively and 4.5% and 5.5% at the packing plant. Results indicated a numerical decrease in EHEC prevalence from feedlot to packing plant for hides and feces (P>.05). Overall prevalence of SAL on hides and in feces at the feedlot were 6% and 18% respectively, while prevalence at the packing plant was 87% and 43%. Data indicated an increase in SAL prevalence from feedlot to packing plant with the only significant increase seen on hides (P<.0001). Twenty percent of pens at the feedlot had positive EHEC feed samples while no feed samples were positive for SAL. Water samples taken at the feedlot indicated 10% of the pens were positive for both EHEC and SAL.

Seven percent of trucks were EHEC positive and 74.5% were SAL positive. Sex significantly affected EHEC status of fecal samples ($P < .05$). Moreover, there was a relationship between sex and SAL status of fecal samples ($P < .10$). Date slaughtered impacted the change of SAL status on hides ($P < .05$). Data indicate a relationship between date slaughtered and change of SAL status in fecal samples ($P < .06$). Available pen space per animal altered the EHEC and SAL in fecal samples ($P < .05$). Truck did not significantly impact EHEC or SAL status.

Key Words: Beef Cattle, *E. coli*, Salmonella

468 Prevalence, incidence, and duration of fecal shedding of *Escherichia coli* O157:H7 by feedlot cattle throughout the feeding period. S Younts^{*1}, D Smith¹, R Moxley¹, J Folmer¹, J Gray², S Hinkley¹, L Hungerford¹, M Khaitsa¹, and T Klopfenstein¹, ¹University of Nebraska-Lincoln, Lincoln, NE, ²USDA, ARS, ARRU, Athens, GA.

The objective of this study was to describe patterns of fecal shedding of *E. coli* O157:H7 in cattle during the feeding period. One hundred steers were randomly assigned to 10 pens (10 animals each) upon arrival. Steers were fed a high concentrate finishing diet for 136 days starting in June. Once a week, fecal samples were collected from the rectum of each animal and cultured for *E. coli* O157:H7. New cases were those animals shedding the organism that had been culture negative the week before. Animals culture negative the prior week were considered the at-risk population. Duration of shedding was the number of consecutive weeks an individual was culture positive. *E. coli* O157:H7 was recovered from each animal at least once during the study. The percentage of pens with at least 1 steer shedding *E. coli* O157:H7 ranged from 10% (week 1) to 100% (weeks 10, 11, 13, 14, 15, 16, 18). The point-prevalence of cattle shedding the pathogen ranged from 1% (week 1) to 80% (week 10). The first 7 weeks of the feeding period were characterized by low incidence (≤ 0.1 new cases/animal-week) of shedding with short mean duration (≤ 2.5 weeks). Incidence increased dramatically in week 9 (0.5 new cases/animal-week), reached a maximum in week 14 (0.7 new cases/animal-week) and then gradually decreased. Mean duration of fecal shedding was longest mid-feeding, lasting 4.7 and 4.8 weeks for weeks 8 and 9 respectively. On the last sampling date, 30% of animals were culture positive, those positive had been shedding the organism a mean of 3.4 weeks, and at least one animal was shedding *E. coli* O157:H7 in 9 of the 10 pens. We concluded that prevalence of *E. coli* O157:H7 shedding within a group of feedlot cattle varied widely by time and space and that variability in prevalence was due to changes in both incidence and duration.

Key Words: Food safety, *E. coli* O157:H7, Feedlot cattle

469 Occurrence of verotoxin-producing *Escherichia coli* in beef and dairy heifers grazing the same pasture. B. H. Thran^{*} and H. S. Hussein, University of Nevada - Reno.

Verotoxin-producing *Escherichia coli* (VTEC) are foodborne pathogens that have been associated with human illness outbreaks due to consumption of contaminated beef or milk. Although there are over 60 VTEC serogroups that have been implicated in human illnesses, research in the U.S. has focused mainly on *E. coli* O157:H7. Therefore, the objective of this study was to assess the occurrence of VTEC in beef and dairy cattle under the same environment during a 1-year period. A herd of 23 yearling Angus heifers and another of 24 yearling Holstein heifers were allowed to graze an irrigated grass pasture with supplementation of alfalfa (*Medicago sativa*) hay only during winter. Each herd was sampled during four periods (spring [April], summer [July], fall [October], and winter [December]) of 1999 resulting in a total of 86 and 91 fecal samples (directly removed from the rectum) for the beef and dairy heifers, respectively. Using classic microbiological methods (based on sorbitol fermentation and 4-methylumbelliferyl- β -D-glucuronide [MUG] metabolism), 290 and 530 potential VTEC isolates were obtained from the beef and dairy heifer samples, respectively. Potential VTEC isolates were tested for verotoxicity and screened by the polymerase chain reaction for the presence or absence of the verotoxin genes (VT1, VT2, or both). The sequence and expression of the verotoxin genes were confirmed. A total of 22 VTEC isolates were detected in both herds. Serotyping of the VTEC isolates identified five isolates from the beef fecal samples as O26. Members of serogroups O6 ($n = 2$), O39 ($n = 1$), O157 ($n = 4$), O113 ($n = 1$) were isolated from dairy fecal samples. In

addition, nine VTEC isolates (one from beef and eight from dairy fecal samples) were unreactive with the 181 "O" and 52 "H" monovalent antisera used for serotyping. Based on detection of both O157 and non-O157 VTEC in our herds, it is clear that screening of cattle for VTEC should not be limited to O157. It is worth noting that members of the serogroups O6 and O26 were previously associated with human illness outbreaks in the U.S. and worldwide. Identification of VTEC-positive cattle prior to slaughter should help in reducing the risk of human foodborne illnesses and can be a critical step in any on-farm strategy to minimize the risk of food contamination with such pathogens.

Key Words: Cattle, Foodborne pathogens, *Escherichia coli*

470 Salmonella isolation on 12 Midwest and Northeast dairy farms. L.D. Warnick^{*1}, J.B. Kaneene², P.L. Ruegg³, S.J. Wells⁴, M. Saeed², C. Fossler⁴, and L. Halbert², ¹Cornell University, Ithaca, NY, ²Michigan State University, East Lansing, MI, ³University of Wisconsin, Madison, WI, ⁴University of Minnesota, St. Paul, MN.

An on-going 3-year longitudinal study is investigating the occurrence, risk factors and antimicrobial resistance patterns of *Campylobacter jejuni* and *Salmonella* on 130 dairy farms. The objective of this part of the project was to compare salmonella isolation among sample sources on 12 dairy farms sampled weekly for 7-8 weeks. Three herds per state were enrolled from MI, MN, NY and WI based upon predefined herd-size criteria. Samples were obtained from target animal populations, bulk tank milk, milk filters, water and feed sources and environmental sites during weekly herd visits and were submitted to a central laboratory for isolation of *Salmonella* using standard laboratory procedures. All herds had *Salmonella* isolated from at least 1 sample. *Salmonella* was isolated from 372 (9.3%) of 4005 fecal samples collected from cattle. The percentage of positive cultures varied significantly among categories of cattle (chi-squared test $P < 0.0001$) and for different environmental sample sources (chi-squared test $P = 0.03$). *Salmonella* was isolated from 8.8% of preweaned calves, 8.0% of healthy lactating cows, 7.1% of designated cull cows, 19.8% of dry cows due to calve within 2 weeks, 13.5% of lactating cows within 2 weeks of calving and from 13.7% of sick cows. The age of preweaned calves and days in milk of healthy lactating cows were not different for cattle with positive cultures compared with those that were culture negative (Wilcoxon rank sum test $P \geq 0.2$). *Salmonella* was isolated from 92 (11.4%) of 807 samples collected from other sources. Samples with *Salmonella* (percent positive) were bulk tank milk (2.2%), milk filters (10.1%), water tanks or drinking cups (13.8%), feed bunks (13.2%), hide swabs from cows designated to be culled (12.1%), calf pens (9.0%), calving pens (13.5%), sick cow pens (24.0%), lagoon or manure piles (14.0%), and bird feces (8.7%). Sample source had a significant effect on detecting *Salmonella* in these infected dairy herds.

Key Words: Dairy Food Safety, Salmonella

471 Isolation of *Mycobacterium paratuberculosis* (*M.ptb*) from thin market cows at slaughter. C.A. Rossiter^{*1} and W.R. Henning², ¹Cornell University, Ithaca, NY, ²Pennsylvania State University, State College.

The study had two objectives: 1. assess the prevalence of Johne's disease in sound, thin (low body condition score, < 2.5 on dairy score 1-5, < 4 on beef score 1-9) dairy and beef cows at slaughter, at high risk of clinical infection; and 2. assess *M.ptb* dissemination to liver (L) and two lymph nodes, the superficial cervical (SC) and the popliteal (P), associated with muscle used in ground product. Cows ($n = 539$) were sampled at 3 large slaughter plants: 189 dairy (primarily one No. East plant) and 350 beef (plants in So. and No. Central U.S.). The study population represented 30-50% of dairy and 10-15% of beef cows processed at the respective plants. On all 539 cows ileocecal lymph nodes (IC) and feces (FC) were cultured for *M.ptb* (Cornell Double Incubation) to diagnose infection. Culture result categories are Maximum (> 299), Moderate (31-299) and Few (1-30) colony forming units (CFU)/0.1 gm. Liver, SC and P were frozen at -70C and later cultured from 135 cows: 25/25 with Maximum/moderate CFUs, 24/49 with Few CFUs, and 86/465 negatives. *M.ptb* was isolated from IC or FC from 65/189 (34%) dairy and 9/350 (3%) beef cows. Relative diagnostic sensitivity based on + IC or FC was twice + FC alone (14% vs. 8%). Culture of L, SC and P isolated *M.ptb* from 16/135 cows (15 dairy, 1 beef) and only from those with Maximum CFUs on both IC and FC indicating disseminated late-stage infection. All 16 were positive on L; 7/16 on SC or P (6 dairy, 1 beef). CFUs were higher in L (9 Moderate, 7 Few) than SC and P

(1 Maximum, 9 Few). All cows with disseminated infection were likely identified, thus *M.ptb* was cultured from L of 16/539 (3%) of sound, thin market cows: 15/189 dairy, 1/350 beef, and only from cows with disseminated infection. *M.ptb* was cultured from SC and P from 7/539 (1.3%) cows, 6 /189 dairy and 1/350 beef. This work suggests occurrence of *M.ptb* in SC and P in the total market cow population is very low. Prevalence and risk associated with disseminated *M.ptb* should be further characterized.

Key Words: Johne's, paratuberculosis, food safety

472 Weekly shedding of *Campylobacter jejuni* on 12 Midwest and Northeast dairy farms. P.L. Ruegg^{*1}, J.B. Kaneene², L.D. Warnick³, S.J. Wells⁴, A.M. Saeed², C. Fossler⁴, and L. Halbert², ¹University of Wisconsin, ²Michigan State University, ³Cornell University, ⁴University of Minnesota.

Campylobacter jejuni has become the most common foodborne cause of diarrhea in humans. An on-going 3-year longitudinal study of 130 dairy herds is studying the occurrence, risk factors and antimicrobial resistance patterns of *C. jejuni* and *Salmonella* spp. obtained from cattle and environmental samples. The objective of this part of the study was to compare shedding of *C. jejuni* from animals located on 12 dairy farms that were sampled weekly for 4 weeks. Three herds per state were enrolled from MI, MN, NY and WI based upon predefined herd-size criteria. Fecal samples were obtained from target animal populations during weekly herd visits and were submitted to a central laboratory for *C. jejuni* isolation using standard laboratory procedures. *C. jejuni* was isolated from 154 of 2106 fecal samples (7.3%, .26 SD) and the prevalence of isolation was significantly different between farms ($F=2.25$, $p=.01$) ranging from 3.7 to 12.0%. *C. jejuni* was isolated from 6.25% (95% CI, 4.0-8.5) of preweaned calves, 7.13% (5.7-8.5) of healthy lactating cows, 12.8% (2.9-22.7) of designated cull cows, 8.4% (3.1-13.8) of close-up dry cows, 12.4% (6.6-18.2) of recently calved cows and 2.7% (.01-6.6) of sick cows. Calves that were culture positive for *C. jejuni* were 13.1 days older than calves that were culture negative ($p=.0002$). Week of sampling was not associated with prevalence of *C. jejuni* (chi-square = 4.4, $p = .22$) during the 4-week period.

Key Words: *Campylobacter jejuni*, Food Safety, Epidemiology

473 Multiple *Campylobacter coli* genotypes from sows and piglets in a commercial swine operation. M. E. Hume^{*}, R. E. Droleskey, and R. B. Harvey, USDA, ARS, SPARC, FFSRU.

Genotypes of *Campylobacter coli* isolates obtained from the feces of three sows, and rectal swabs from seventeen piglets from a farrow-to-finish swine operation were examined by pulsed field gel electrophoresis (PFGE). Five *C. coli* colonies were picked from a single culture plate for each sample following differential broth enrichment and growth on Campy-Cefex agar. Isolate genotypes were examined by PFGE following genomic DNA restriction endonuclease digestion with *SmaI* and *SacII*. Twenty-three *SmaI* and thirteen *SacII* genotypes were detected among ninety-nine *C. coli* isolates. One *SmaI* genotype was detected among isolates from each of two sows and each of seven piglets, two different genotypes were among isolates from one sow and each of seven piglets, and three different genotypes were detected in each of three piglets. Digestion with *SacII* revealed one genotype among isolates from each of two sows and eight piglets, two genotypes among isolates from each of eight piglets, and three genotypes among isolates from each of two piglets. Although some piglets were related to sows in the study and some were littermates, there was no discernable pattern of shared genotypes among piglets and their respective sows or between related piglets. Data indicate that the pigs had been exposed to multiple *C. coli* genotypes, and that detection of co-colonizing genotypes is possible by PFGE.

Key Words: *Campylobacter*, Swine, Pulsed Field Gel Electrophoresis

474 Chlorate supplementation in drinking water reduces *E. coli* O157:H7 populations in cattle prior to harvest. T. R. Callaway^{*1}, R. C. Anderson¹, T. J. Anderson¹, T. L. Poole¹, and D. J. Nisbet¹, ¹Agricultural Research Service/USDA-Southern Plains Agricultural Research Center.

Cattle are a natural reservoir of *E. coli* O157:H7. Therefore, strategies that reduce *E. coli* O157:H7 in cattle will reduce human exposures to this pathogen. Nitrate reductase converts nitrate to nitrite, but also co-metabolically reduces chlorate to chlorite, which is cytotoxic to bacteria. Nitrate reductase-positive bacteria (e.g., *E. coli*) exposed to chlorate die. As a result of this bactericidal effect, it was suggested that chlorate be used as a strategy to reduce *E. coli* O157:H7 in cattle prior to harvest. This study was designed to determine the effect of chlorate treatment on experimentally inoculated *E. coli* O157:H7 populations in cattle. Cattle ($n=8$) were fed a feedlot-style high grain ration, and were experimentally infected with 3 strains of *E. coli* O157:H7 identified via different antibiotic resistance markers. Fecal and ruminal counts of each O157:H7 strain, as well as generic *E. coli* and total coliforms were determined prior to chlorate treatment. Cattle were given access to drinking water supplemented with 2.5 mM KNO_3 and 100 mM NaCl (Controls) or 2.5 mM KNO_3 and 100 mM $NaClO_3$ (Treatment). Sodium chlorate treatment reduced the population of each O157:H7 strain approximately 2 logs (from 10^4 to 10^2) in the rumen and from 10^6 to 10^3 in the feces. Chlorate treatment reduced total coliforms and generic *E. coli* from 10^6 to 10^4 in the rumen and by 3 logs throughout the rest of the gastrointestinal tract (ileum, cecum, colon and rectum). Strains of *E. coli* O157:H7 were reduced throughout the intestinal tract. Chlorate treatment did not alter total culturable anaerobic bacterial counts. Therefore, it appears that chlorate supplementation is a potential strategy to reduce *E. coli* O157:H7 populations in cattle prior to harvest.

Key Words: *E. coli* O157:H8, Pre-harvest intervention, Sodium chlorate supplementation

475 Integron gene sequences within poultry farms and processing plants. M.T. Roe^{*1}, A. Byrd², D. Smith³, and S. D. Pillai¹, ¹Texas A&M University, College Station, TX, ²United States Dept. of Agriculture, College Station, TX, ³Gainesville College, Gainesville, GA.

The dissemination of multiple antibiotic resistant bacteria is a major issue in the poultry industry. It has been shown that the integron gene sequence plays an important role in the transfer of antibiotic resistance cassettes between pathogens. The objective of this study was to examine the occurrence of integron gene sequences within poultry production and processing. Microbial community DNA from chicken carcass wash samples at key points within poultry farm and processing plants were PCR analyzed utilizing primers specific for the 5# and 3# conserved segments of the integron gene sequence to determine the presence of integrons in sample DNA. Out of 96 total samples, 51% of the samples were positive for the integron sequence. Seventy-one % of on farm samples were integron positive, while, 66%, 46%, and 42% were positive at the post-feather removal, pre-chiller tank immersion, and post-chiller tank immersion location of a processing plant respectively. When two independent chiller immersion tanks were sampled at four discrete points over a 48-hour period, integron sequences were repeatedly detectable. These results indicate that integron sequences are widely distributed within poultry production and processing. Thus, there are multiple locations at which lateral gene transfer of antibiotic resistance gene cassettes can potentially occur.

Key Words: Antibiotic Resistance, Integron Gene Sequence, Poultry Processing

476 Detection of transgenic DNA in bovine milk: Results for cows receiving a TMR containing maize grain modified for insect protection (MON810). R.H. Phipps^{*1}, D.E. Beaver¹, and A.P. Tingey², ¹The University of Reading, Reading, UK., ²Reading Scientific Services Ltd, Reading, UK. .

The aim of the study was to determine the presence or absence in bovine milk of transgenic DNA as a result of animals consuming maize grain genetically modified (GM) for insect resistance by the Bt gene (event MON810). Ten Holstein/Friesian cows (mean days in milk 207, milk yield 25.3 kg/d, DM intake 20.8 kg/d and live-weight 639 kg) received a

TMR, in which the forage component was grass and maize silage (non-GM) in a 1:3 DM ratio and formed 55% of the TMR DM. In study weeks 1-3 the TMR DM also contained non-GM supplements of 18.5% cracked wheat, 26.1% rapeseed meal and 0.4% minerals. In weeks 4-12 ground maize grain (MON810) replaced cracked wheat. Milk and TMR samples were taken weekly prior to and after the introduction of the GM diet. In milk samples spiked with Bt DNA, PCR analyses established a minimum detection level (MDL) of transgenic DNA, of 7.5 g/l of milk. Subsequent semi quantitative PCR analyses were carried out in duplicate on TMR and milk samples using three primer sets to establish the presence of GM DNA. Two of the maize primer sets recognise different regions of the Cauliflower Mosaic Virus (CaMV) 35S promoter and the third covers the integration site of the MON810 inserted DNA. The PCR analysis was capable of detecting GM DNA fragments greater than or equal to 200 base pairs (bp) in length. The feed and milk samples analysed at week 3 when cows received a TMR containing no GM feed ingredients were negative. The TMR feed samples at weeks 4 and 12 were positive for MON810 maize DNA, but all milk samples were negative. In conclusion the results show that GM DNA could not be detected in milk (MDL 7.5 g/l of milk) from cows receiving 18.5% of their diet DM as insect protected (MON810) maize grain. The study was funded by the Milk Development Council and the Dairy Industry Federation.

Key Words: Dairy cows, GM feed ingredients, Transgenic DNA

477 Assessment of novel feeds in animal nutrition. Karen Aulrich* and Gerhard Flachowsky, *Institute of Animal Nutrition, Federal Agricultural Research Centre.*

Apart from feed safety assessment including safety for consumers, animals and environment, nutritional assessment of feeds produced using recombinant DNA techniques (Genetically Modified Organism, GMO) is necessary. In 1997 we started a program to assess GMO's of the so-called first generation (feed plants with changed tolerance or resistance and with minor changes in content of valuable and desirable ingredients) including Bt-corn, Pat-corn, Pat-sugar beets and Gt-soybeans. Apart from main nutrients (crude protein, ether extract, crude fiber, crude ash), amino acids, fatty acids, minerals, fiber components and some mycotoxins were determined in seeds of corn and soybeans, sugar beets and silages from corn and sugar beet leaves. Digestion and feeding experiments were carried out with broilers (Bt-corn), layers (Bt-corn, Pat-corn), pigs (Bt-corn, Pat-corn, Pat-sugar beets, soybeans), sheep (Bt-corn silage, Pat-corn silage, Pat-sugar beet silage), growing bulls (Bt-corn silage) and fistulated cows (Bt-corn silage). Digestibility of nutrients, performance of animals and fate of DNA were investigated. Up to now, we did not find significant differences in nutritional assessment and food quality between feeds from isogenic and transgenic plants of the first generation, except a lower mycotoxin-content (deoxynivalenol and zearalenon) in Bt-corn. The so-called substantial equivalence could be demonstrated. Fragments of plant DNA could be detected in some animal tissues (e.g. muscle from chicken), but fragments of transgenic

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479 Lutalyse alters the immune response in sows after intrauterine inoculation with bacteria. M. C. Wulster-Radcliffe*¹, R. C. Seals², and G. S. Lewis¹, ¹USDA-ARS United States Sheep Experiment Station, ²University of Virginia.

During luteolysis, increases in PGF_{2α} and decreases in progesterone lead to clearance of uterine infections. Thus, we conducted an experiment to determine whether Lutalyse, a PGF_{2α} analogue, alters the uterine immune response to bacterial challenge in the absence of luteolysis and the concomitant decrease in progesterone. Sows (n = 6/group) were assigned to treatments in a 2 × 2 factorial array; bacterial challenge and Lutalyse were main effects. Vena caval blood was collected daily on d 7 through 11 of the estrous cycle. On d 7, uteri were inoculated with either PBS or 70 × 10⁷ cfu of *Escherichia coli* and 150 × 10⁷ cfu of *Arcanobacterium pyogenes* in PBS (10 mL). On d 9, saline (2 mL) or Lutalyse (10 mg) was injected i.m. On d 11, uteri were collected. Sediment (packed-cell volume; PCV) and ability to culture *E. coli* and *A. pyogenes* from uterine flushings were used to diagnose infections. Differential white blood cell counts and basal and mitogen-stimulated lymphocyte proliferation were used to evaluate immune function. All bacteria-treated sows developed uterine infections. Sows treated with bacteria and Lu-

talyse had less severe infections than sows treated with bacteria and saline (PCV = 25 vs 67%; P < 0.01). No PBS-treated sows developed infections (PCV < 5%). Neither Lutalyse nor bacteria affected progesterone (64 ng/mL) or estradiol-17β (< 1 ng/mL), indicating that luteolysis did not occur. Basal (10.2 vs 2.3 pmol) and lipopolysaccharide-stimulated incorporation (6.8 vs 2.9 pmol) of [³H]thymidine into newly formed lymphocytes was greater (P < 0.01) for Lutalyse-treated than for saline-treated sows. Lutalyse, compared with saline, increased vena caval PGF_{2α} (0.44 vs 0.28 ng/mL; P < 0.05), and Lutalyse increased neutrophils (65 vs 84/100 WBC; P < 0.01) and decreased lymphocytes (28 vs 16/100 WBC; P < 0.01). Thus, exogenous PGF_{2α} can initiate clearance of uterine infections without inducing luteolysis and decreasing progesterone and (or) increasing estradiol-17β concentrations; effects of PGF_{2α} seem somewhat independent of changes in progesterone and estradiol-17β.

Key Words: Novel feeds, Animal nutrition, Genetically modified organism

478 Differences in Transfer of Nicarbazine, Meticlorpindol and Ivermectin from Feed to Milk. C.A. Kan*¹, C.A.J. Hajee², J.A. van Rhijn², A. Klop¹, T. Zuidema², B.J.A. Berendsen², and H.J. Keukens², ¹ID TNO Animal Nutrition, P.O. Box 65, 8200 AB Lelystad, The Netherlands, ²RIKILT, P.O. Box 230, 6700 AE Wageningen, The Netherlands.

Cross contamination during feed production may result in contamination of feeds with feed additives or veterinary drugs. This may lead to contamination of milk, but the extent to which residues might occur was not known. We carried out carry-over experiments with nicarbazine, meticlorpindol and ivermectin. 6 Groups of 4 cows each (both high [> 35 kg/day] and low [<20 kg/day] producing ones) received concentrate artificially contaminated at three different levels. The high-producing cows received 12 kg and the low producing ones 2 kg concentrate per cow per day. The contaminated feed was fed for three weeks. During exposure and at least 7 days post-exposure, milk samples were collected and mixed samples per group were analysed. Two cows (one high and one low producing one) served as controls. Milk samples were analysed by validated HPLC methods with UV or fluorescence detection. The LOQ in milk for nicarbazine and meticlorpindol was 25 ng/g and for ivermectin 0.1 ng/ml. Feed levels were in the 1-12.5 mg/kg range for nicarbazine, in the 2.5-25 mg/kg range for meticlorpindol and in the 0.3-3 mg/kg range for ivermectin. Nicarbazine (measured as DNC) could not be detected in any of the milk samples. Very low levels could be detected in body fat samples of some animals slaughtered after about 8 days withdrawal. Meticlorpindol was found in milk at levels between 5 and 50 ng/g during feeding the contaminated feed only. The levels scattered, but generally a dose-response relationship between levels in feed and in milk could be established. Ivermectin was found in milk throughout the whole exposure period and up to 10 days post-exposure. Levels up to 7 ng/g were found and good dose-response relationships between feed and milk level could be established. These data show that absorption from feed and excretion into milk of these three compounds in dairy cows differed considerably. No general pattern could be deduced from these data and no general conclusion on risks of residues in milk due to cross contamination in feed mills could be drawn.

Key Words: Nicarbazine in milk, Meticlorpindol in milk, Ivermectin in milk

talyse had less severe infections than sows treated with bacteria and saline (PCV = 25 vs 67%; P < 0.01). No PBS-treated sows developed infections (PCV < 5%). Neither Lutalyse nor bacteria affected progesterone (64 ng/mL) or estradiol-17β (< 1 ng/mL), indicating that luteolysis did not occur. Basal (10.2 vs 2.3 pmol) and lipopolysaccharide-stimulated incorporation (6.8 vs 2.9 pmol) of [³H]thymidine into newly formed lymphocytes was greater (P < 0.01) for Lutalyse-treated than for saline-treated sows. Lutalyse, compared with saline, increased vena caval PGF_{2α} (0.44 vs 0.28 ng/mL; P < 0.05), and Lutalyse increased neutrophils (65 vs 84/100 WBC; P < 0.01) and decreased lymphocytes (28 vs 16/100 WBC; P < 0.01). Thus, exogenous PGF_{2α} can initiate clearance of uterine infections without inducing luteolysis and decreasing progesterone and (or) increasing estradiol-17β concentrations; effects of PGF_{2α} seem somewhat independent of changes in progesterone and estradiol-17β.

Key Words: Infection, Sow, Lutalyse

480 Lutalyse can up-regulate the uterine immune system in the presence of progesterone. G. S. Lewis* and M. C. Wulster-Radcliffe, *USDA-ARS United States Sheep Experiment Station.*

In luteal-phase ewes with uterine infections, Lutalyse, a PGF_{2α} analogue, treatment induces luteolysis and clearance of the infections. However, the direct effects of Lutalyse on uterine infections and its effects through luteolysis (i.e., decreased progesterone [P4]) are completely confounded. Thus, this experiment was conducted to determine whether Lutalyse alters the uterine immune response if P4 is maintained. Ewes (n = 8/group) were assigned to treatments in a 2 × 2 × 2 factorial array; ovariectomy, P4 treatment, and Lutalyse were main effects. On d 0 of the estrous cycle, ewes were either sham ovariectomized or ovariectomized. After ovariectomy, either sesame oil (2.5 mL) or P4 (5 mg) in oil was injected i.m. twice daily. On d 6, uteri were inoculated with 70 × 10⁷ cfu of *Escherichia coli* and 150 × 10⁷ cfu of *Arcanobacterium pyogenes* in PBS (5mL). On d 9, saline (2 mL) or Lutalyse (15 mg) was injected i.m. Vena caval blood was collected daily on d 9 through 11, and uteri were collected on d 12. Sediment (packed-cell volume; PCV) and ability to culture *E. coli* and *A. pyogenes* from uterine flushings were used to diagnose infections. Basal and mitogen-stimulated lymphocyte proliferation were used to evaluate immune function. All ewes developed infections. However, compared with controls, infections were less severe (P < 0.01) in the absence of ovarian or supplemental P4 (PCV = 7 vs 15%) or after Lutalyse (PCV = 8 vs 15%). Basal and concanavalin A (Con A)- and lipopolysaccharide (LPS)-stimulated lymphocyte proliferation increased over time (P < 0.01). Basal (1.356 vs 1.710 optical density units [OD]) and Con A- (2.18 vs 2.47 OD) and LPS-stimulated proliferation (1.75 vs 2.12 OD) were greater (P < 0.01) for Lutalyse than for saline-treated ewes. Basal proliferation was less (P < 0.01) for P4- than for oil-treated ewes. After ovariectomy, Con A-stimulated proliferation increased (2.23 vs 2.41 OD; P < 0.05). We conclude that exogenous PGF_{2α} can initiate clearance of uterine infections, independent of inducing luteolysis and decreasing P4 concentrations.

Key Words: Lutalyse, Sheep, Infection

481 Incidence of anestrus in suckled beef and milked dairy cattle. J.S. Stevenson*, *Kansas State University.*

Early conception of suckled cows is limited by the proportion of cows that are cycling at the beginning of the breeding season. Although prolonged anestrus generally is not limiting in milked cattle, negative energy balances are associated with prolonged anestrus. In more than 2,200 beef cows studied, body condition (BC), parity, and days in milk (DIM) influenced the proportion of cows cycling (cyclicality; determined by measuring blood progesterone) before the onset of the breeding season. As BC increased from <4 to >5.5 (1 = thin and 9 = fat), cyclicality increased (P<0.05) by 18.2% for each unit increase in BC. Cyclicality increased linearly from 25% (<50 d) to a peak after 70 DIM (60%). For every 10-d interval from <50 to >80 d, cyclicality increased (P<0.05) by 7.5.07%. Compared to older cows (53%), fewer (P<0.01) 2-yr-old cows with their first calves were cycling (44%), despite calving up to 3 wk earlier. Dairy cows on three farms were studied (milk yields ≥10,000 kg). In one study of 678 cows (milked 2× daily), the average cyclicality was 82% by 40 to 68 DIM. In first-lactation cows, cyclicality was lower (P<0.05) in one herd (72%) than in the second herd (87%), whereas no differences were detected for older cows (88 vs. 86%). Body condition (1 = thin and 5 = fat) assessed at time of blood sampling averaged 2.3.05. For each 0.5-unit increase in BC, cyclicality increased (P<0.01) by 4.6.22%. For each 10-d increase in DIM, cyclicality increased (P<0.01) by 6.1.17%. In a second study of 251 cows in one herd (milked 3× daily), cyclicality was only 44% by 47 to 67 d. First vs. later lactating cows (40 vs. 55%) were less (P < 0.05) likely to be cycling. Again, BC averaged about 2.3.05. As BC increased by 0.5 units, cyclicality increased (P<0.05) by 24.3.49%. Milk yield had no influence on cyclicality. In the last study of 367 cows in three herds (milked 2× daily) during the summer, cyclicality was 84% by 56 to 83 d. In this study, lactation number did not affect cyclicality, but BC (average of 2.4.05) increased (P<0.05) cyclicality by 8.5.23% for every 0.5-unit increase in BC. Further, suckled and milked cows not cycling by the beginning of the breeding period conceived at lesser rates and took longer to eventually conceive.

Key Words: Anestrus, Suckled cows, Milked cows

482 Plasma and luteal progesterone influence *in vivo* embryo development in day 5 post-estrus Holstein Friesian cows. MP Green*¹, MG Hunter¹, and GE Mann¹, ¹*University of Nottingham, Loughborough, Leicestershire, UK.*

Previous studies have demonstrated a close relationship between maternal progesterone and degree of embryo development on day 16 in dairy cows. The aim of the present study was to relate stage of embryo development on day 5 post-estrus to maternal progesterone secretion. Twenty Holstein Friesian cows (parity 1-9) were inseminated at synchronised estrus. Animals were slaughtered on day 5 post-oestrus, (estrus=Day 0) blood samples taken, CL removed and oviducts and uteri flushed. In total, 11 animals (55%) had 15 potentially viable embryos (4 double ovulations). A potentially viable embryo was defined as being intact; non-viable embryos were those with broken or empty zones. Viable embryos collected (n=15) were found to be at a range of development stages; 8-cell (n=7), 9-16 cell (n=4) and morula (n=4). Up to the morula stage all embryos were in the oviduct. Morulae were recovered from the uterus from two of the three animals. Mean plasma progesterone, luteal weight and progesterone concentrations (n=11) were 1.2ng/ml ±0.6ng/ml, 1.8g ±0.9g and 30.2µg/CL ±15.8µg/CL respectively. Plasma progesterone concentrations and progesterone:oestradiol ratio within animals increased significantly (p<0.001) over and between (p<0.05) the three developmental stages recovered. CL weight (p<0.05) and progesterone content µg/CL (p<0.01) increased significantly with stage of embryo development. Moreover, linear regression analysis demonstrated day 5 plasma progesterone increased significantly with CL weight (p<0.01) and luteal progesterone content (µg/CL) (p<0.01). The results demonstrate a close relationship between the degree of embryo development and both plasma and luteal progesterone as early as day 5. This provides further evidence that progesterone is fundamental to early embryo development and survival in the dairy cow. (Funded by Ministry of Agriculture Fisheries and Food, UK)

Key Words: Progesterone, Corpus luteum, Embryo

483 Effects of high plasma urea nitrogen levels on bovine embryo quality and development. M. L. Bode*, R. O. Gilbert, and W. R. Butler, *Cornell University, Ithaca, NY.*

Lactating dairy cows (n = 23) were fed diets designed to result in plasma urea nitrogen (PUN) levels either <19 mg/dL (LD; n = 12) or >19 mg/dL (HD; n = 11). After 30 days on diets, the cows were synchronized for estrus and superovulated in preparation for embryo flushing. Concentrations of PUN were 16.1 and 24.1 mg/dL for LD and HD cows, respectively. Embryos were recovered non-surgically on day 7 after estrus and evaluated for quality and stage of development. Embryos graded as 1 or 2 (n = 96) were frozen for direct transfer to heifer recipients. Virgin heifers (n = 122; 12 to 20 months of age) were fed diets designed to result in either low or high PUN levels (LR, HR; PUN of 8.1 and 25.1 mg/dL for LR and HR, respectively). After 30 days on diets, the estrous cycles of the heifers were synchronized. Embryos were transferred on day 7 after estrus to heifers that exhibited a palpable corpus luteum, forming four experimental groups (HD/HR, HD/LR, LD/HR, LD/LR). There were no differences in the quantity, visual quality, or stage of development of embryos collected from LD cows or HD cows. However, the embryos from the LD cows resulted in a higher pregnancy rate than the embryos from HD cows (35.1% versus 11.1% for low and high PUN, respectively; P < 0.02). Neither the diet of the heifer receiving the embryo or the combination of the donor and recipient diets had a significant effect on pregnancy rate (P > 0.05). In a second experiment, heifers (n = 39) continuing on the same low and high PUN diets as the embryo recipient heifers were synchronized for estrus and artificially inseminated. The circulating level of PUN did not affect the pregnancy rate (P > 0.95). The results of this study indicate that high PUN levels in lactating dairy cows on or before day 7 of pregnancy is deleterious to the viability of the embryo. High PUN in heifers did not affect pregnancy rate, suggesting interaction of high PUN with other conditions in cows *eg.* negative energy balance. However, further research is necessary to determine the mechanism(s) for this detrimental effect.

Key Words: cows, embryo, urea

484 Early gestational modification of conceptus development in sheep. M. E. Wilson*, B. A. Costine, and E. K. Inskip, *West Virginia University*.

The importance of the early uterine environment in determining conceptus growth and survival in livestock species is becoming more evident. These studies were conducted to determine if early gestational treatment with growth hormone could influence lamb birth weights and if treatment with estradiol would influence IGF-I content in the uterine lumen. In experiment I, estrus was synchronized with CIDR devices, inserted for 14 d, and ewes were assigned at random to receive either no treatment (n = 20) or 154 mg of recombinant bovine growth hormone (Posilac; n = 20) at the withdrawal of progesterone. Ewes were housed with fertile rams at a ewe:ram ratio of 12:1 and mating was recorded. Blood samples were collected on d 6 after estrus for quantification of progesterone and both free and total IGF-I. Each ewe was examined by transrectal ultrasonography 40 d after estrus for determination of pregnancy and enumeration of the fetuses present. At lambing, type of birth, birth weight and sex of each lamb were recorded. In experiment II, 16 ewes (n = 4 per treatment) were assigned to receive 0, 125, 250 or 500 g of estradiol on d 5 and 6 after mating (d 0 is estrus). Uterine luminal contents were collected on d 7 after mating for determination of IGF-I content. Treatment with growth hormone did not alter circulating concentrations of progesterone 6 d after estrus (2.6 ± 0.2 ng/ml, $P > 0.10$). However, growth hormone increased ($P < 0.001$) both free (0.70 ± 0.04 vs 4.37 ± 0.68 ng/ml) and total (177 ± 13 vs 490 ± 5 ng/ml) circulating IGF-I 6 d after estrus. Treatment of ewes with bovine growth hormone prior to breeding tended to increase ($P < 0.07$) birth weight of lambs (5.1 ± 0.2 kg vs 4.5 ± 0.2). Treatment of ewes on d 5 and 6 of gestation with 125 and 250 g of estradiol did not increase uterine luminal IGF-I content (5.5 ± 2.2 and 6.1 ± 1.7 ng) when compared to controls (8.4 ± 1.5 ng). However, 500 g of estradiol resulted in an increase ($P < 0.05$; 14.4 ± 2.5 ng) in uterine luminal IGF-I content when compared to controls. These data support our suggestion that modulation of early uterine environment with growth hormone, and potentially estradiol, may modify conceptus development.

Key Words: Ewe, Pregnancy, Conceptus development

485 Use of recombinant GnRH antigens for immunosterilization of beef heifers. T. W. Geary*¹, E. E. Grings¹, M. D. MacNeil¹, S. E. Bellows¹, K. P. Bertrand², D. M. de Avila², and J. J. Reeves², ¹USDA-ARS, Fort Keogh LARRL, Miles City, MT, ²Washington State University, Pullman.

Beef heifers (n = 47) were allotted by age (mean = 8.5 mo) and weight (mean = 238 kg) to evaluate immunosterilization with one of three different GnRH antigens or control. Each heifer received a primary immunization at wk 0 and booster immunizations at wk 6 and 12 containing 1 mg of protein in 1 mL of adjuvant administered in the mammary gland. Heifers were immunized against either a fusion protein consisting of thioredoxin with seven GnRH peptides (tGnRH), a fusion protein consisting of ovalbumin with seven GnRH peptides (oGnRH), a cocktail of tGnRH/oGnRH, or a cocktail containing thioredoxin and ovalbumin (control). Six heifers within each treatment received Synovex H implants at wk #2. Weekly blood samples were collected from wk #2 to 26 to determine serum progesterone concentrations and GnRH antibody titers. GnRH antibody titers increased after the first booster injection, peaked after the second, and remained elevated through the end of the study for GnRH immunized heifers ($P < 0.01$). Heifers that were immunized against oGnRH had greater ($P < 0.05$) GnRH antibody titers than tGnRH heifers but did not differ ($P = 0.20$) from tGnRH/oGnRH heifers. Estrous cycles were suppressed ($P < 0.05$) in 10/12, 12/12, 11/12 and 0/11 tGnRH, oGnRH, tGnRH/oGnRH, and control heifers, respectively. At slaughter, uterovarian weights were lighter ($P < 0.01$) for GnRH immunized heifers than controls. Synovex H implanted heifers had greater ADG from wk 6 to 26 and wk #2 to 26, greater REA, and lower %KPH, yield grade, and quality grade than non-implanted heifers. We conclude that immunization against the tGnRH, oGnRH and tGnRH/oGnRH fusion proteins produced anti-GnRH antibodies that suppressed estrous cycles in 83, 100 and 92% of heifers, respectively, without affecting feedlot or carcass performance. Implanting heifers with Synovex H improved ADG, REA, and yield grade. Protocols that yield greater than 95% estrous suppression may someday replace surgical spaying of heifers.

Key Words: GnRH, Heifers, Sterilization

486 Induction of the "ram-effect" and response to estrus induction procedures in Fall born ewe lambs. M. Knights*¹, Q. S. Baptiste¹, and P. E. Lewis¹, *West Virginia University, Morgantown, WV*.

The ability of ram introduction (RI) to induce the "ram-effect" and the ability of progesterone (P4) pre-treatment and RI to induce estrus and ovulation in Fall born lambs during the anestrus season was investigated. In early July lambs of mixed breeds (41.8 ± 0.6 kg and 250.7 ± 1.3 d) were assigned to be untreated (C, n=7), introduced to rams (7:1 ewe:ram ratio; R, n=7), treated with a CIDR device for 5 d (P, n=5), treated with a CIDR device and introduced to rams at CIDR removal (PR, n=11), or given estradiol (25 mg, E2b i.m.) 24 h after CIDR withdrawal/RI (PER, n=11). Blood samples were collected from lambs in groups R, P and C every 4 h for 60 h from RI/CIDR withdrawal (0 h), to characterize the LH surge profile and in groups R and C every 15 minutes from 12 to 20 h for determination of LH pulse frequencies. Ultrasonographic examinations of the ovaries were conducted at 0, 36 and 60 h. Observations for estrus was done every 4 h from 0 to 60 h. Lambs in group R had a higher LH pulse frequency than C lambs ($P < 0.01$; 7.7 ± 0.5 and 2.7 ± 0.8 pulses/8h for group R and C, respectively). More lambs in the R group than in P or C groups showed an LH surge and ovulated ($P < 0.05$; 7/7 vs 0/5 and 0/7, and 6/7 vs 0/5 and 0/6 for groups R, P and C, respectively). Diameter of the largest follicle at 0 h (3.2 ± 0.1 mm) was not different among groups. Growth rate of the largest follicle between 0 and 36 h was greater in RI groups than group C ($P < 0.05$; 1.5 ± 0.2 , 1.3 ± 0.3 , 0.86 ± 0.3 , -0.11 ± 0.6 mm/d for lambs in R, PR, PER, and C groups). Diameter of the largest follicle at 36 h was 5.6 ± 0.2 , 5.1 ± 0.5 , 4.3 ± 0.4 , and 4.0 ± 0.6 for lambs in R, PR, PER, P and C groups, respectively and was larger ($P < 0.05$) in R than PER, P and C, and in PR than P groups. Number of follicles 3 mm was not different among groups at 0 (1.6 ± 0.1) or 36h (1.3 ± 0.5), but was greater at 60 h in C (1.7 ± 0.4) than in R (0.7 ± 0.2), PR (0.6 ± 0.2) and PER (0.3 ± 0.2) groups. Estrus was observed in 73, 45 and 0 % of lambs in PER, PR and R groups, respectively, and was greater ($P < 0.05$) in P4 pre-treated lambs (PER and PR) than R lambs. During seasonal anestrus, fall born ewe lambs show a typical "ram-effect" response to RI further, P4 pre-treatment and RI when combined with E2 results in a high estrus response.

Key Words: Fall born ewe lambs, Ram-effect, Anestrus

487 Uterine responses to a graded dose of genistein in postpubertal gilts. J.A. Ford, Jr.* and W.L. Hurley, *University of Illinois, Urbana, Illinois*.

Phytoestrogens can affect the reproductive tract in some mammalian species. The objectives were to characterize the change in uterine wet and dry weights in gilts following administration of a graded dose of the soybean phytoestrogen, genistein. Twenty postpubertal gilts were ovariectomized in order to remove endogenous estrogen. The gilts were randomly assigned to one of five treatment groups 15 d post ovariectomy. Genistein was solubilized in DMSO prior to mixing with peanut oil vehicle. Treatment groups received either no hormone (G0) or genistein at 50 mg / d (G50), 100 mg / d (G100), 200 mg / d (G200), or 400 mg / d (G400). Treatments were administered by IM injection at 12-h intervals for 10 d. Gilts were slaughtered after the 10 d of injections. Uteri were collected at the time of slaughter, trimmed of all extraneous tissue, and weighed. Dry weights were determined by freeze-drying a portion of the sample. Uterine wet weight increased as the dosage of genistein increased ($p < .01$; 103.1 ± 43.8 g for G0, 108.7 ± 33.6 g for G50, 108.5 ± 23.8 g for G100, 174.0 ± 34.7 g for G200 and 249.5 ± 70.7 g for G400). Uterine wet weight standardized for body weight increased as the dosage of genistein increased ($p < .01$; 71.3 ± 28.1 g / 100 kg BW for G0, 78.1 ± 21.2 g / 100 kg BW for G50, 78.8 ± 14.6 g / 100 kg BW for G100, 126.4 ± 19.9 g / 100 kg BW for G200 and 171.2 ± 48.1 g / 100 kg BW for G400). Uterine dry weight increased as the dosage of genistein increased ($p < .03$; 17.3 ± 7.6 g for G0, 19.5 ± 3.5 g for G50, 20.7 ± 5.9 g for G100, 27.9 ± 6.6 g for G200 and 35.6 ± 8.2 g for G400). Uterine dry weight standardized for body weight increased as the dosage of genistein increased ($p < .02$; 11.9 ± 4.9 g / 100 kg BW for G0, 13.5 ± 2.1 g / 100 kg BW for G50, 14.4 ± 3.8 g / 100 kg BW for G100, 20.0 ± 3.8 g / 100 kg BW for G200 and 24.5 ± 5.5 g / 100 kg BW for G400). Hydration percentage was unchanged in the uterine samples ($p > .26$; 83.5 ± 1.4 % for G0, 84.4 ± 1.9 % for G50, 82.1 ± 2.2 % for G100, 84.2 ± 1.2 % for G200 and 85.1 ± 1.8 % for G400). A graded dose of genistein causes a significant

increase in uterine wet and dry weights, but does not change the proportion of water in uterine tissue in ovariectomized postpubertal gilts. Administration of high doses of the soybean phytoestrogen, genistein, may affect reproductive tract development and function.

Key Words: gilt, phytoestrogen, uterus

488 Pancreatic insulin response and tissue responsiveness to insulin in dry cows, lactating cows and cows suffering from fatty liver: results of hyperglycemic and hyperinsulinemic euglycemic clamp experiments. M. Kaske*, K. Herzog, S. Kraeft, and J. Rehage, *Clinic for Cattle, School of Veterinary Medicine, D - 30173 Hannover, Germany.*

First objective was to study the pancreatic insulin response to glucose in 5 dry cows (mean \pm SEM: 38 \pm 11 d ap), 5 lactating cows (47 \pm 11 d pp; 28 \pm 2 kg milk/d) and 5 early-lactating cows suffering from fatty liver (increased liver enzymes, liver triglycerides > 50 mg/g; 20 \pm 2 d pp). During the euglycemic clamp, blood glucose was clamped at 4 mM for 2 h by adapting glucose infusion rate according to the blood glucose concentration measured every 5 min. Plasma insulin and non-esterified fatty acids (NEFA) were analyzed repeatedly. The amount of glucose necessary to clamp blood glucose was higher for lactating cows than for dry cows and fatty liver cows (15.5 \pm 1.6, 9.8 \pm 1.4, 10.1 \pm 2.5 μ mol/kg/min, respectively). The pancreatic insulin response to glucose infusion was twice as high in dry cows (steady-state plasma insulin during glucose infusion about 30 μ U/ml) than in lactating cows and fatty liver cows which reached comparable steady-state insulin concentrations during glucose infusion (about 15 μ U/ml). In all groups, irrespectively of marked differences in the basal NEFA concentrations, NEFA dropped during glucose infusion by about 40 %. Second objective was to compare the responsiveness of peripheral tissues to insulin. Each 5 or 6 dry cows (22 \pm 2 d ap), lactating cows (42 \pm 7 d pp), early-lactating fatty liver cows (21 \pm 3 d pp) and early-lactating ketotic fatty liver cows (plasma hydroxybutyrate > 1.5 mM; 18 \pm 5 d pp) received bovine insulin intravenously in amounts of 0.1, 0.5, 2.0, 5.0 and 10.0 mU/kg/min consecutively for 2 h each. Blood glucose was clamped at the basal level by infusing varying rates of glucose. The maximal insulin response defined as the mean steady-state glucose infusion rate during infusion of 10 mU insulin/kg/min was higher in lactating cows than in dry cows; the response was further reduced in fatty liver cows and lowest in ketotic fatty liver cows (35.8 \pm 3.0, 28.2 \pm 0.7, 22.4 \pm 1.3, 14.5 \pm 1.4 μ mol/kg/min, respectively). It is suggested that the insulin resistance of fatty liver cows could be due to post-binding defects in insulin action and/or a depletion of GLUT-4. Results further emphasize that basal plasma concentrations of insulin do not reflect the extent of insulin resistance in cows.

Key Words: Insulin, Clamp, Fatty liver

489 Effect of feeding level on rumen papillae is mediated by IGF-1. Zan-Ming Shen^{1,2}, Berthold Lhrke¹, Falk Schneider¹, Hartmut Franz¹, Arthur Chudy¹, Siegfried Kuhla¹, Rudolf Zitnan^{1,4}, Holger Martens³, and Hans Hagemeister¹, ¹Research Institute for Biology of Farm Animals Dummerstorf, Germany, ²Nanjing Agriculture University, China, ³Berlin Free University, Germany, ⁴Research Institute of Animal production Nitra, Slovakia.

Eight male goats (4-month) were individually fed with grass hay (ad lib.) and concentrate 1.1 kg/d (HL) or 0.3 kg/d (LL) for 41-d to study the effect of feed intake on the rumen papillae development and function as well as IGF-1 profile *in vivo* and to test the effect of IGF-1 on rumen epithelial cell proliferation *in vitro*. The plasma IGF-1 (RIA), ruminal VFA and weight gain were measured before and weekly during experiment. On d 42 of experiment, the papillae size and ion transport (Ussing-chamber) was determined. The isolated epithelial cells were incubated with (25 ng/ml and 50 ng/ml) or without IGF-1 to measure the cell cycle *in vitro*. The HL treatment significantly increased daily weight gain ($P < .05$) and plasma IGF-1 concentration. Compared with LL treatment, the papillae size and surface of rumen epithelium was larger (717, 476 and 110 vs 1626, 1089 and 242 mm²/cm², $P < .05$) in the atrium, ventral rumen sac and ventral blind sac and, the rumen transport of Na⁺ across the epithelium (ventral rumen) was significantly increased by HL treatment. The total VFA concentration was almost identical, but the mole percentage of ruminal butyric and propionic acid was higher in HL ($P < .05$). *In vitro*, 25 ng/ml of IGF-1 increased S and S+G₂ phase cells in LL ($P < .05$ and $P < .10$) and S phase cell in HL ($P <$

.10) treatment, but 50 ng/ml administration did not. The cell number of S phase ($P < .05$) and S+G₂ phase ($P < .05$) were enhanced in HL by 25 ng/ml of IGF-1. The results *in vivo* show a correlation between concentrate feeding, plasma IGF-1 and rumen papillae development. The *in vitro* results suggest that IGF-1 promotes rumen epithelial cell proliferation and that the response of epithelial cell to IGF-1 was regulated by feeding level. In conclusion, the results support the assumption that the effect of feeding level on rumen papillae development is mediated by IGF-1.

Key Words: Feeding level, IGF-1, Rumen papillae

490 Influence of solar radiation and feeding level on feed and water intake, digestibility, thermo-respiratory response and some blood constituents in sheep. Mostafa Kobeisy^{*1}, Faisal Elhommosi¹, Galal Abdel-Hafiz¹, and Hassanain Badawy^{2, 1} *Animal Prod. Dept., Fac. of Agric., Assiut University, Assiut-Egypt., ²Desert Research Center, Cairo-Egypt.*

This study was carried out to investigate the effect of exposure to the direct solar radiation on both feed and water intakes, digestibility of nutrients, thermo-respiratory response, some blood constituents, thyroid (T3&T4) and cortisol hormone. Six clinically healthy saidi rams over one year old and had an average body weight of 40 kg were used in this study. Animals were subjected to solar radiation from 9.00 to 16.00 h and maintained outdoors all over the days of trial throughout July. Feed and water intake were recorded. Blood samples were taken for Hb, PCV %, and serum total protein, albumin, globulin, triglycerides, cholesterol, AST, ALT, T3,T4 and cortisol determination. Respiration and rectal temperature were recorded. Digestibility coefficient were determined. The digestibility coefficients of DM, OM, CP, NFE, ADF and ADF were higher ($P < 0.01$) in animals exposed to direct sun rays than those non-exposed. Respiration rate and rectal, skin and wool temperatures revealed higher ($P < 0.01$) values after exposure to direct sun light than that before exposure. Solar radiation decreased ($P < 0.01$) serum glucose, cholesterol and cortisol hormones concentrations. Animals fed ad libitum level of nutrition had higher ($P < 0.01$) PCV, % than those fed restricted level, particularly after sun exposure. Animals exposed to solar radiation had lower concentrations of glucose and cholesterol.

Key Words: Sheep, solar radiation, digestibility, blood, thermo-respiratory response

491 Cortisol, insulin, triiodothyronine and weight gain in Hereford and Senepol steers on endophyte-infected tall fescue or orchardgrass. R. Browning, Jr.*¹, N. Whittingham, and T. Payton, *Tennessee State University, Nashville.*

Heat-sensitive Hereford (278 kg; n = 30; H) and heat-tolerant Senepol (261 kg; n = 28; S) steers were fed endophyte-infected tall fescue (TF) or orchardgrass (OG) to assess the effect of heat tolerance in cattle on physiological responses to endophytic fescue. Following a pretreatment diet of OG hay, 15 H and 14 S steers were fed TF hay and seed, while the remaining 29 steers were fed OG hay and seed. The study was from mid-June to mid-October of 2000 with experimental diets starting in mid-July. Steers were weighed and bled at 2-wk intervals for 4 mo. Cumulative weight gain was similar for the groups during the 1-mo pretreatment period (21, 20, 26, and 25 \pm 3 kg for HOG, HTF, SOG, and STF, respectively). Weight gain was affected ($P < 0.03$) by a breed \times diet interaction after 1 mo of treatment. Weight loss in HTF (-19 \pm 3 kg) differed ($P < 0.01$) from weight maintenance in STF (1 \pm 3 kg), which in turn differed ($P < 0.01$) from weight gain by HOG and SOG (11 and 17 \pm 3 kg, respectively). After 3 mo on the experimental diets, breed \times diet affected ($P < 0.001$) cumulative weight gain with HTF exhibiting lower ($P < 0.01$) total weight gain (28 \pm 3 kg) compared to STF, SOG, and HOG (48, 50, and 56 \pm 3 kg, respectively). Plasma insulin and triiodothyronine concentrations were affected by a breed \times diet \times time interaction ($P < 0.05$). During the first 2 mo of dietary treatment, mean triiodothyronine concentrations were higher ($P < 0.01$) for STF (126 \pm 3 ng/mL) compared to HTF, HOG, and SOG (104, 107, and 107 \pm 3 ng/mL, respectively). During the first month on experimental diets, HTF had lower ($P < 0.001$) insulin concentrations (3.7 \pm 0.3 μ IU/mL) compared to SOG, STF, and HOG (5.4, 6.0, and 6.2 \pm 0.3 μ IU/mL, respectively). Plasma cortisol concentrations

were not affected by a 3-way or diet \times time interaction. Results suggest that heat tolerance in steers can modify physiological responses to endophyte-infected tall fescue.

Key Words: Fescue Toxicosis, Cattle Breeds, Heat Tolerance

492 The effect of supplemental feed at parturition in the rainy season on hair sheep ewe performance in the tropics. R.W. Godfrey*, W. Gonzales, and R.E. Dodson, *University of the Virgin Islands, Agricultural Experiment Station, St. Croix.*

St. Croix White and Barbados Blackbelly hair sheep ewes were used to evaluate the effect of supplemental nutrition around lambing on ewe and lamb performance during the wet season on St. Croix. Beginning 14 d prior to expected day of lambing (day 0) and for 21 d postpartum, 11 ewes were fed a pelleted complete ration (17% crude protein) at a level to provide 150% of the nutrient requirements, in addition to grazing guinea grass pasture (FEED). Twelve ewes grazed pasture only (CONTROL). This study was conducted during October through January. Total rainfall during this time was 212 mm and forage dry matter ranged from .77 to 2.49 MG/ha. The 24-hr milk production of all ewes was measured on days 7, 21, 35, 49 and 63. Ewes were given 1 IU of oxytocin (i.v.) and

milked by hand and separated from their lambs. Four hours later ewes were hand milked again, using oxytocin, and the milk from the second milking was weighed to determine 24-hr milk production. Ewes were exposed to sterile rams equipped with marking harnesses to detect estrus during the postpartum period. Lambs were weaned at 63 d of age. Data were analyzed by SAS using treatment and days postpartum as main effects. The CONTROL ewes lost a higher percentage ($P < .05$) of their pre-lambing weight during lactation than FEED ewes. There was no difference ($P > .10$) in milk production between FEED and CONTROL ewes. The time to first postpartum estrus was less ($P < .03$) in FEED than in CONTROL ewes (33.0 ± 2.5 vs 41.1 ± 2.4 d, respectively). Litter birth weight was similar ($P > .10$) for FEED and CONTROL ewes ($4.2 \pm .5$ vs $4.9 \pm .4$ kg, respectively). Lamb weaning weight was not different ($P > .10$) for lambs raised by FEED or CONTROL ewes ($17.3 \pm .9$ vs $15.8 \pm .8$ kg, respectively). There was no difference ($P > .10$) in ADG of lambs in the FEED or CONTROL groups (222.1 ± 13.6 vs 200.4 ± 11.9 g/d, respectively). Supplementation of hair sheep ewes around parturition during the rainy season in the tropics does not appear to enhance ewe or lamb production traits.

Key Words: Sheep, Lamb, Milk Production

ASAS/ADSA Ruminant Nutrition: Fat Nutrition/Feed Intake

493 Effect of feeding different sources of supplemental fat on the performance of lactating buffaloes. H. Nawaz, M. Abdullah*, and G. Mohiuddin, *University of Agriculture, Faisalabad, PAKISTAN.*

Four early lactating Nili-Ravi buffaloes were fed four experimental diets either containing no added fat (control) or tallow, poultry fat or mustard oil at 3 per cent of diet dry matter in a 4 \times 4 Latin Square Design. The intakes of DM, and CP decreased ($p < 0.05$) in buffaloes fed diet supplemented with tallow or poultry fat compared to either control or diet containing mustard oil. Intake of NEL were significantly higher in buffaloes consuming mustard oil versus those fed the control diet or diets containing tallow or poultry fat (21.4 vs. 19.6 19.0 19.4 Mcal/d, respectively). Average daily production of milk and 4 percent FCM, was significantly higher in buffaloes fed diets containing supplemental fat (13.0, 20.6, kg/d) vs. in those fed the control diet (10.6, 16.0, kg/d), respectively. Milk fat percentage was significantly higher (8.38 %) in buffaloes consuming diet supplemented with tallow than in those fed diet supplemented with poultry fat (7.90 %), mustard oil (7.45 %) or control diet (7.41 %). The concentrations of C8:0 to C16:1 fatty acids were lower (39.16 vs. 59.13 %) while those of C18:0 to C20:0 were higher (59.69 vs. 40.04 %) in milk fat of buffaloes fed diets containing supplemental fat than in those fed the control diet. Total solids contents were higher for buffaloes consuming tallow-supplemented diet (17.75 %) versus those fed the control (16.47 %), poultry fat (17.27 %) or mustard oil (16.56 %) supplemented diets. The GE of milk (Kcal/kg) and total GE of milk (Mcal/d) were higher for buffaloes consuming the tallow-supplemented diet (1221 and 15.7) compared with the control (1063 and 11.2) or diet containing mustard oil 1074 and 13.7). Digestibility of DM was significantly higher in animals fed diet-containing tallow (71.3 %) than in those fed the control diet (69.9 %). The digestion coefficient of EE increased significantly in buffaloes fed diets containing tallow (75.9 %) and poultry fat (73.8 %) versus the control (70.2 %) or the diet containing mustard oil (69.4 %). Significantly lower ratios of acetate to propionate were observed in buffaloes fed different fat sources (2.6) than the control diet (3.18).

Key Words: Supplemental fat, Buffaloes, Milk production, Digestibility

494 Effect of feeding different levels of supplemental tallow on the performance of lactating buffaloes. M. Abdullah*, H. Nawaz, and G. Mohiuddin, *University of Agriculture, Faisalabad, PAKISTAN.*

Four early lactating Nili-Ravi buffaloes were fed four experimental diets containing 0, 2, 4 or 6 % tallow in a 4 \times 4 Latin Square Design. The intakes of DM, OM, CP, ADF and NDF decreased ($p < 0.01$) but intake of EE ($p < 0.01$) and DE ($p < 0.05$) increased with increasing levels of tallow in the diets. Intake of NEL did not differ significantly with varying levels of supplemental tallow. Daily milk yield increased (from 11.0 to

13.2 kg/d, $p < 0.01$), production of 4 percent FCM, SCM, and ECM increased quadratically ($p < 0.05$) with the increasing level of tallow in the diets. Milk fat content and total milk fat increased respectively with increasing levels of tallow. The proportion of C8:0 to C16:1 fatty acids decreased (53.66 to 35.52 %), whereas, concentration of C18:0 to C20:0 increased (44.93 to 62.84 %) in milk fat of buffaloes fed diets containing different levels of tallow. No differences were observed in concentration of milk protein and lactose among control and those fed different levels of tallow. Total solids contents increased (16.45 to 17.67 %, $p < 0.05$) but SNF percentages did not vary with varying levels of tallow. The GE of milk (Kcal/kg) increased (1096 to 1160, $p < 0.01$) with increasing levels of tallow in the diets. Energetic efficiency of milk production improved in a quadratic ($p < 0.05$) manner with 2, 4 and 6 percent tallow, highest (47.6 %) with 4 % supplemental tallow. The digestibility of DM and OM was 66.4 & 63.4, 67.9 & 64.9, 70.6 & 67.2 and 67.4 & 62.7 %, ($p < 0.05$) with 0, 2, 4 and 6 % supplemental tallow in the experimental diets, respectively. The digestibility of CP did not differ, while that of EE improved (68.2 to 74.5 %, $p < 0.01$). The blood pH and concentration of glucose did not vary significantly due to varying levels of tallow in the diets. The concentrations of cholesterol, triglycerides and blood lipids increased ($p < 0.01$) with increasing levels of tallow. A linear ($p < 0.01$) decrease in acetate to propionate ratio was observed with increasing levels of tallow in the diets (3.24 to 2.66, $p < 0.01$).

Key Words: Supplemental tallow, Buffaloes, Milk production, Digestibility

495 A two-year study measuring the reproductive performance of dairy cows fed soybeans. A. Mowrey*, J. N. Spain, M. C. Lucy, M. R. Ellersieck, and K. L. Fritsche, *University of Missouri - Columbia.*

Two studies were conducted during two consecutive years to evaluate the effects of fat supplementation on milk production and reproduction in dairy cows. Year 1 (Y1) utilized a randomized complete block design with 84 early lactation dairy cows fed a control diet or a diet with either raw cracked soybeans or a rumen inert fat product added. In Year 2 (Y2), 68 early lactation dairy cows were fed a control diet or one of three diets containing increasing amounts of soybeans. Cows received treatments beginning two weeks post-calving and were fed assigned treatment until animals were inseminated (Y1) or until 70-d post calving (Y2). Milk yield, milk components, intake, body weight and plasma progesterone were measured. During Y1, pretreatment and experimental milk yield was significantly higher for control and soybean-fed cows ($P \leq 0.05$). Fat-corrected milk yield was not different among diets. Dry matter intake followed the same trend as milk yield, averaging less for cows fed inert fat; as a percent of body weight these changes were not significant. Plasma stearic acid increased following feeding of the diets containing supplemental fat. Progesterone concentrations changed little due to dietary treatments. Ultrasonographic measures of follicular

and corpus luteum growth during Y1 were similar for cows fed different diets. During Y2, production parameters of milk yield and DMI were unchanged. Milk protein percentage decreased significantly as level of soybeans increased, although yield of milk protein was similar. Plasma cholesterol increased from day one until the end of the study and increased as fat was added to the diets. Plasma stearic and linoleic acid was highest in cows fed the diets containing soybeans. Percentage of cows in estrus after estrous synchronization was 87.2% (Y1) and 71% (Y2) and conception rate to the synchronized estrus was 41.2% (Y1) and 38% (Y2), both were similar across diets. In summary, raw soybeans were fed to lactating dairy cows without significant decreases in production, ovarian activity, or conception rate.

Key Words: Dairy cows, Reproduction, Plasma fatty acids

496 Interactions of Rumensin premix and diet on milk fat percentage in lactating dairy cattle. T Duffield^{*1}, R Bagg², D Kelton¹, and P Dick², ¹Department of Population Medicine, University of Guelph, ²Elanco Division of Eli Lilly Canada Inc.

A total of 91 Ontario Holstein dairy herds were surveyed in the spring of 1999 for general lactating cow ration information and the use of Rumensin[®] premix in their lactating cow diets. In addition, herds were asked to submit wet forage and TMR samples to the Ontario Veterinary College for evaluation of particle size. All herds were enrolled in Ontario Dairy Herd Improvement (DHI) milk recording. Four DHI tests near the time of the feed sampling (March to June) were selected and pooled to calculate the herd mean milk fat percentage. To avoid the confounding effects of stage of lactation, the herd mean milk fat test was calculated for only those cows that were between 100 and 200 days in milk at the time of each DHI test.

Of the 91 herds in the study, 80 fed haylage, 79 fed corn silage, and 58 herds fed a TMR. There were 15% of haylage samples, 14% of corn silage samples and 42% of TMR samples that were below the lower guidelines for the top screen of the Penn State particle separator. These were classified as low fiber samples. In total there were 33 herds that were not using Rumensin in the lactating cow diet and 58 herds that were. Concentrations of Rumensin in feed ranged from 8 to 23 ppm, with a median of 14 ppm. Significant interactions of diet and Rumensin with milk fat are illustrated in the table below.

There appears to be important dietary factors that may allow the prediction of milk fat response to Rumensin in dairy herds. Rations that are deficient in effective fiber appear more susceptible to milk fat depression with Rumensin. In addition, low NSC (< 40.2) diets were more susceptible to milk fat depression with Rumensin than those diets high in NSC (≥ 40.2). Further research is required to fully assess and test these ration interactions with Rumensin.

Ration Parameter	Rumensin in the Ration		p-value
	No	Yes	
TMR	3.61	3.39	0.007
Component	3.62	3.58	0.580
Low Fiber TMR	3.68	3.36	0.001
Normal Fiber TMR	3.60	3.44	0.060
High NSC	3.59	3.58	0.920
Normal NSC	3.75	3.40	0.001

Key Words: Monensin, Milk fat, Effective fiber

497 Effect of supplemental fat and monensin on ruminal fermentation in dual-flow continuous cultures. M. Croucher, S. J. McLeod, and V. Fellner*, North Carolina State University, Raleigh, NC.

Approximately 700 ml of rumen inoculum was obtained from a mature lactating Holstein and incubated in fermentors with a fractional liquid dilution rate of 6.3%/h. Basal diet comprised of alfalfa pellets (7.5g) offered twice daily. Two treatments were assigned to four fermentors (n=2) for a total period of 8 d including 2 d of adaptation to diet and fermentor. Treatments consisted of: 1) Monensin (30 ppm; 450 µg/d) administered for 2 d followed by 4 d of the addition of both monensin and fat (linoleic acid; .450g/d), and 2) Linoleic acid (.450 g/d) added for 2 d followed by 4 d of the addition of both fat and monensin (450 µg/d). Data were analyzed as repeated measures. Both treatments resulted in a lower proportion of acetate and a higher proportion of propionate in ruminal cultures. However the change in VFA pattern was greater when

monensin was added prior to the fat (treatment 1). During the control period C18:0 comprised more than 60% of the long chain fatty acids in ruminal cultures. Treatment 1 resulted in a lower (P <.01) C18:0 content (25.8%) and a higher (P <.05) C18:1 content (28.4%) compared with 55.4% and 17.9%, respectively for treatment 2. The concentration of C18:2 in cultures during the control period averaged 1.4%. Treatment 1 increased (P <.01) C18:2 content which averaged 19.3% compared to the 5.5% observed in cultures receiving treatment 2. The presence of linoleic acid prior to the addition of monensin minimized the effect of the ionophore on ruminal biohydrogenation.

Key Words: Fat, Ionophore, Rumen fatty acid

498 Formulating high fat rations for lactating dairy cattle according to a ratio of metabolizable protein to net energy. V. Pattarajinda*, M. A. Froetschel, H. E. Amos, D. Kumar, and A.A. Gautreaux, The University of Georgia, Athens.

Four Holstein cows in mid lactation were used in a 4x4 Latin square designed experiment with a 2x2 factorial arrangement of treatments to determine if higher levels of fat could be more effectively utilized when a ratio of metabolizable protein (MP) to NE_L was maintained. Four diets were formulated to contain : 1) 45% RUP and 7.6% fat (HRHF), 2) 45% RUP and 3.2% fat (HRLF), 3) 35%RUP and 7.6% fat (LRHF), and 4) 35% RUP and 3.2% fat (LRLF). Whole cottonseed supplied a basal level of dietary fat (5%) and calcium soaps of fatty acids were used as additional fat. Soybean meal was used as the main protein supplement for the 35 % RUP diets and a blend of heat- processed soybean meal, fish meal, blood meal and dried distillers grains were used as sources of RUP for the 45% RUP diets. Feed was offered as a TMR and contained approximately 50% sorghum silage. The metabolizable protein (MP) / NE_L ratio was estimated as 75.7, 83.8, 67.6, and 75.6 g of MP/ Mcal of NE_L in HRHF, HRLF, LRHF, and LRLF, respectively. Intake (% BW) of cattle fed the HRHF diet was depressed 4.7 to 10.4% as compared to the other diets. Milk production was increased by 2.8% by feeding RUP and decreased 2.4% by feeding additional fat. Milk fat (%) was increased 5.5 % by feeding additional fat. Feeding RUP tended to decrease the digestion of DM (DMD) and NDF (NDFD) by 4.6 and 5.7%, respectively. Diet NE_L, predicted from apparent digestible energy, was 9.1% greater in diets with added fat. Efficiency of NE_L used for milk (EE milk) was decreased 11.9 to 13.9% when cattle were fed the lowest ratio of MP/ NE_L. Blood urea N (BUN) was increased 45.9% higher when cattle were fed diets higher in fat. There appears to be some advantages to maintaining a proper MP/ NE_L ratio when feeding high fat diets and encourages the use of this parameter when formulating rations.

Item						RUP	Fat	INT
	HRHF	HRLF	LRHF	LRLF	SEM	P<	P<	P<
DMI, kg/d	20.3	21.5	22.1	22.0	.8	.02	.14	.09
DMI, %BW	3.37	3.76	3.53	3.61	.05	.01	.88	.03
Milk, kg/d	28.7	29.6	28.0	28.7	.3	.02	.03	.73
Milk fat, %	3.72	3.57	3.9	3.65	.08	.17	.05	.67
Milk CP, %	2.79	2.83	2.77	2.85	.04	.95	.21	.67
DMD, %	64.1	63.3	65.5	68.0	1.4	.07	.58	.29
NDFD, %	58.3	55.2	59.3	61.0	1.8	.09	.69	.22
NE _L , Mcal/kg	1.74	1.65	1.84	1.63	.06	.51	.04	.37
EE milk, %	56.7	56.7	48.8	55.4	1.6	.02	.06	.03
BUN, mg/dL	19.4	12.8	20.3	14.3	.74	.16	.01	.71

Key Words: Metabolizable protein, Dietary fat, Dairy cattle

499 Effects of feeding different sources of neutral detergent-soluble carbohydrates supplemented with fat and propionate to heat stressed dairy cows. A. M. Akinyode*, M. B. Hall, J. P. Jennings, C. R. Staples, and C. J. Wilcox, *Univ. of Florida, Gainesville.*

The effects of different forms of energy supplementation on the lactation performance of heat stressed cows was evaluated. Thirty-two Holstein cows in mid-lactation were assigned to eight treatments in a 2 x 2 x 2 factorial, partially balanced incomplete Latin square design with three 21-d periods in which the last 7 days were used for sampling. The treatments consisted of citrus pulp- or hominy-based diets (C and H, respectively), with or without propionate supplementation from 0.73% of diet DM as Nutrocal® (P), and with or without fat supplementation from 0.6% of diet DM as Megalac® (F). Cows were fed individually in a freestall barn, with shade, but without additional cooling. Rectal temperatures (RT) and respiration rates (RR) were taken twice daily, and blood samples once daily on days 1, 3, 5, and 7. Values reported are least squares means. Significance was declared at $P < 0.05$. Main effects did not differ for body weight (BW), or morning and afternoon RR (MRR and ARR). Significant factors affecting ARR were milk yield and BW ($R^2 = 0.39$), and BW alone for MRR ($R^2 = 0.23$). P reduced morning RT (MRT), but not afternoon RT (ART). RT and RR were correlated ($r = 0.45$). Decreased intake with P may have been due to dustiness of the product used and decreased palatability. In this study, the effects of treatments on animal performance were limited.

Item	C	H	-P	+P	-F	+F
DMI, kg/d	19.0**	20.6**	20.2*	19.4*	20.1	19.4
MRT°C	39.6	39.8	40.1*	39.3*	39.7	39.8
ART°C	39.5	39.4	39.4	39.4	39.4	39.5
Insulin, ng/ml	0.89	0.92	0.89	0.92	0.92	0.89
Plasma glucose, mg/dl	90.1	91.3	90.3	91.1	90.1	91.2
Milk yield, kg/d	22.1	23.2	23.5*	21.8*	22.3	22.9
Milk protein, kg/d	0.70	0.71	0.72	0.69	0.70	0.71
Milk fat, kg/d	0.81	0.82	0.87**	0.77**	0.82	0.82
MUN, mg/dl	16.1	15.6	16.1	15.7	15.3**	16.4**
Milk/DMI	1.22	1.17	1.24	1.15	1.14	1.24

** $P < 0.05$; * $P < 0.10$

Key Words: Heat Stress, Dairy Cows, Energy Supplements

500 An alternative approach to determine the efficiency of energy utilization for milk production in lactating dairy cows. E. Kebreab*¹, J. France¹, R.E. Agnew², and T. Yan², ¹The University of Reading, Reading, United Kingdom, ²Agricultural Research Institute of Northern Ireland, Hillsborough, United Kingdom.

The current energy requirements system used in the UK for lactating dairy cows utilizes key parameters such as metabolizable energy intake (MEI) at maintenance (MEIm), the efficiency of utilization of MEI for (i) maintenance, (ii) milk production (k_l) (iii) growth (k_g), and the efficiency of utilization of body stores for milk production (k_b). Traditionally, these have been determined using linear regression methods to analyze energy balance data from calorimetry experiments. Many studies have highlighted a number of concerns over current energy feeding systems particularly in relation to these key parameters. Underlying these concerns could be the rigid acceptance of linear methods in analyzing energy balance data from dairy cows. Therefore, a database containing 456 individual cow records was created from centers with calorimetry facilities in the UK. Five functions were considered: the conventional 'broken-stick', two diminishing returns functions - the Mitscherlich and the rectangular hyperbola and two sigmoidal functions - the logistic and the Gompertz. Based on the definition of k_l as the ratio of milk energy derived from MEI to MEI directed towards milk production, zero energy balance (± 5 MJ) were used to estimate regression parameters to determine MEIm, and k_l . Positive and negative energy balance data were used to estimate k_g and k_b , respectively. Values of 0.8 and 0.65 were obtained using all the functions for k_g and k_b , respectively, which were significantly different from previous reports of 0.6 for k_g and 0.84 for k_b . When all the data were pooled, the average k_l was 0.61. Non-linear analysis showed a decreasing value of k_l as feeding level above maintenance increases. Various factors affecting k_l were also analyzed. Lower k_l was obtained in experiments conducted after 1991, perhaps due to differences in the genetic merit of the cows. It also showed k_l to be

influenced by forage type, forage:concentrate ratio, ADF content, and stage of lactation.

Key Words: Energy utilization, Dairy cows

501 Effects of dietary supplementation of rumen-protected CLA in dairy cows during established lactation. J. W. Perfield II*, G. Bernal-Santos, T. R. Overton, and D. E. Bauman, *Cornell University, Ithaca, NY.*

Specific isomers of conjugated linoleic acids (CLA) have anticarcinogenic properties (*cis-9, trans-11* CLA), and reduce milk fat synthesis (*trans-10, cis-12* CLA). Short-term studies have shown that abomasal infusion of CLA or dietary supplements of rumen-protected CLA can enhance CLA content and/or reduce fat content of milk. Our objective was to assess effects of CLA supplementation during established lactation. Thirty Holstein cows were blocked by parity and received either a supplement of 116 g of EnerG II (Bioproducts, Inc) (control) or 126 g/d of CLA supplement. Supplements were topdressed on the TMR. The CLA supplement provided 42.8 g/d of CLA in the form of rumen-protected calcium salts (donated by Agribrands Purina Canada Inc.). Predominant CLA isomers were: *trans-8, cis-10* (9.2%), *cis-9, trans-11* (25.1%), *trans-10, cis-12* (28.9%), and *cis-11, trans-13* (16.1%). All cows were pregnant; treatments began 200 d prepartum and continued for 140 d until dry off. This report presents preliminary data covering the first 8 wk of treatment. The greatest treatment effect was on milk fat. Cows receiving CLA had a lower milk fat test (2.82 vs. 3.72%; $P < 0.001$) and a 20% reduction in milk fat yield (1048 vs. 1310 g/d; $P < 0.001$). CLA supplemented cows had a trend for increased milk yield (36.9 vs. 35.2 kg/d; $P < 0.09$) while milk protein yield was unchanged (1118 vs. 1088). The CLA group produced less 3.5% FCM (33.1 vs. 36.8 kg/d; $P < 0.01$), but DMI was similar between groups (23.7 vs. 24.3 kg/d). Milk fatty acid analysis indicated CLA supplemented cows had a reduced content of short and medium chain fatty acids, whereas concentration of longer chain fatty acids was increased. Changes in specific fatty acids indicated that Δ^9 -desaturase was reduced for the CLA treatment group. CLA fed animals also had an increased milk fat content of *cis-9, trans-11* CLA (0.53 vs. 0.47%) and *trans-10, cis-12* CLA (0.04 vs. <0.01%). Overall, feeding rumen-protected CLA resulted in a marked reduction in milk fat, a shift in milk fatty acid composition, a small increase in milk yield, and no change in milk protein.

Key Words: CLA, Milk Fat

502 Effect of pretrial milk yield on feed intake, digestion, and production responses to high- and low-fiber diets by dairy cows. J.A. Voelker*¹, G.M. Burato², and M.S. Allen¹, ¹Michigan State University, ²University of Padova, Italy.

Effect of dietary concentration of NDF on DMI, DM digestibility, and milk yield was evaluated using 32 Holstein cows in a crossover design with two 16 d periods. Cows were 193 ± 55 (mean \pm SD) DIM at the beginning of the experiment. Milk yield averaged 36.3 kg/d and ranged from 20.7 to 58.2 kg/d for the 14 d before initiation of treatments. Treatments were diets with forage to concentrate ratios of 67:33 and 44:56. Forages were alfalfa silage and corn silage, each at 50% of forage DM. Diets were formulated to 17.5% crude protein, and the NDF concentration of the high-NDF (H) and low-NDF (L) diets were 30.7% and 24.3% of DM, respectively. Greater digestibility of dietary DM was expected for L compared to H because grain is more digestible than forage. However, treatment did not affect DM digestibility, because digestibility of NDF and starch were greater ($P < 0.01$ for both) for H (33.2% and 89.7%, respectively) compared to L (26.9% and 86.0%, respectively). A greater increase in body condition score was observed for L compared to H ($P < 0.05$). No effects of treatment were observed for DMI, yield of milk or 3.5% fat-corrected milk (FCM), or percentage of milk components. However, individual DMI response to treatment (L-H) was positively correlated to pre-trial milk yield ($r = 0.43$, $P = 0.02$). DMI response (L-H) increased 0.127 kg/d per kg of pre-trial 3.5% FCM. Responses for yields of milk and fat-corrected milk to the low-fiber diet (L-H) showed a positive, quadratic relationship to pretrial milk yield ($P < 0.01$ for both). No relationship existed between milk composition response (L-H) and pretrial milk yield. The positive linear relationship observed between DMI response to the less filling, low NDF diet (L-H)

and pre-trial milk yield is consistent with the hypothesis that physical fill becomes a greater limitation on DMI as milk yield increases.

Key Words: Dietary NDF, Physical fill, Feed intake regulation

503 Dose-response effects of intra-ruminal infusion of propionate on feeding behavior of lactating dairy cows. M. Oba* and M. Allen, *Michigan State University, East Lansing, MI.*

Dose-response effects of intra-ruminal infusion of propionate on feeding behavior of lactating dairy cows were evaluated. Eight ruminally cannulated Holstein cows (159 ± 26 DIM; mean ± SD) were used in a duplicated 4 x 4 Latin square design. Treatments were mixtures of sodium propionate and sodium acetate infused into the rumen continuously for 14 h at a rate of 25 mmol/min. Treatment solutions contained 0, 33, 67, or 100% sodium propionate (treatment A, B, C, or D, respectively) and sodium acetate was added to keep the osmolarity of infusates constant across the treatments. The experimental diet was formulated to contain 29% NDF, and dry cracked corn (mean particle size = 3.6 mm) was the major source of starch. Infusion started 2 h before feeding and ended 12 h after feeding. Feeding behavior was monitored for 12 h after feeding using a computerized data acquisition system. As infusion of propionate increased, dry matter intake decreased linearly ($P < 0.0001$; 15.0, 13.3, 11.5, and 8.3 kg/12 h, respectively for treatment A, B, C, and D), meal size decreased linearly ($P = 0.02$; 2.5, 2.0, 2.1, and 1.5 kg of DM, respectively for treatment A, B, C, and D), and inter-meal interval tended to increase linearly ($P = 0.08$; 75.4, 76.3, 87.7, and 90.1 min, respectively for treatment A, B, C, and D). Total energy intake was calculated by adding the energy of infusates to dietary energy intake. Total energy intake also decreased linearly ($P < 0.0001$; 30.0, 28.2, 25.9, and 21.5 Mcal NE_L/12h, respectively for treatment A, B, C, and D) as infusion of propionate increased. This indicates that the reduction in dietary energy intake due to propionate infusion was greater than the energy supplied from propionate infusions. Our results demonstrate that propionate plays an important role in feed intake regulation by affecting both satiety and hunger, and can explain depressed energy intake of lactating dairy cows consuming highly fermentable diets.

Key Words: propionate, feed intake regulation

504 Effects of intra-ruminal infusion of propionate salts on feeding behavior of lactating dairy cows. M. Oba* and M. Allen, *Michigan State University, East Lansing, MI.*

Two experiments were conducted to evaluate effects of intra-ruminal infusion of propionate salts on feeding behavior of lactating dairy cows. Our working hypothesis is that hepatic metabolism of propionate causes satiety by increasing hepatic ATP concentration. We speculate that enhanced ATP concentration drives the Na/K pump, hyperpolarizes the hepatic vagus, decreasing its discharge rate, causing satiety. For both experiments, eight ruminally cannulated Holstein cows in mid-lactation were used in a duplicated 4 x 4 Latin square design, and intra-ruminal infusion started 2 h before feeding and ended 12 h after feeding. Treatments in the first experiment were mixtures of propionic acid and bicarbonate salt (none, ammonium, sodium, or potassium). Bicarbonate salts were infused at a rate of 11.9 mmol/min, and propionic acid was infused at a rate of 16.7 mmol/min for all treatments. We speculated that infusion of ammonium reduces the hypophagic effects of propionate because of utilization of ATP for urea synthesis and that infusion of sodium or potassium affects DMI by altering the discharge rate of the hepatic vagus. However, infusion of ammonium propionate tended to decrease DMI compared to sodium propionate and potassium propionate ($P < 0.08$; 11.2 vs. 13.6 and 13.7 kg/12 h), and DMI was not different between sodium propionate and potassium propionate infusions. In the second experiment, effects of VFA (propionate vs. acetate) and salt type (sodium vs. ammonium) on DMI were evaluated using a 2 x 2 factorial arrangement of treatments. The VFA salts were infused at a rate of 16.7 mmol/min. Ammonium treatment decreased DMI compared to sodium treatments ($P < 0.001$), and the effect of ammonium was significantly greater for cows infused with propionate (11.6 vs. 4.7 kg/12 h) compared to acetate (14.7 vs. 13.8 kg/12 h; interaction $P < 0.0001$). Contrary to our pre-trial hypothesis, ammonium has hypophagic effects,

which might be because the urea cycle generates substrate for oxidation in the liver, increasing hepatic ATP concentration and decreasing DMI.

Key Words: feed intake regulation, propionate, ammonium

505 Characteristics of forages and TMR fed to dairy cows in Washington state dairy herds producing in excess of 12,730 kg of milk annually. L. M. Johnson*¹, J. H. Harrison¹, W. Schager¹, D. Davidson¹, S. Chen², C. Stockle², F. Hoisington³, and C. A. Rotz⁴, ¹Washington State University, Puyallup, WA, ²Washington State University, Pullman, WA, ³Dari-Tech Services, Kent, WA, ⁴USDA-ARS, University Park, PA.

The chemical composition of forages and TMR from seven Holstein dairy herds producing greater than 12,730 kg of milk annually were characterized to identify factors that contributed to high milk production. Forages and TMR for the high producing mature cow string in each herd were analyzed for CP, acid detergent insoluble CP (ADICP), starch, NDF, fat, Ca, P, Mg, K, and dietary cation-anion difference (DCAD). The concentration of CP and NDF in the TMR were above recommended ranges according to NRC (2001) for high producing mature cows in early lactation, except for NDF concentrations at Farm 1. The concentration of ADICP was under 2% indicating minimal bound protein in the diets. Calcium concentrations ranged from 23 to 78% greater and P concentrations ranged from 13 to 32% greater than NRC (2001) recommended levels for a sample diet that had similar animal and feed characteristics to this study. Magnesium concentrations were 33 to 129% greater and K concentrations were 42 to 87% greater than NRC (2001) recommended levels for a sample diet. The DCAD concentration in the TMR was between 26 and 39 meq/100 g DM. These levels for DCAD in early lactation postpartum diets have been shown to maximize milk production in other studies. The corn silages ranged from 47 to 57% NDF and from 13 to 26% starch. The alfalfa hay samples ranged from 19 to 28% CP and from 38 to 46% NDF.

Farm	TMR									
	CP %	ADICP %	Fat %	Starch %	NDF %	Ca %	P %	Mg %	K %	DCAD meq/100 g DM
1	18.5	1.7	6.0	17.9	30.6	1.07	0.50	0.45	1.71	27.6
2	17.8	2.0	7.0	17.1	34.5	1.00	0.49	0.41	1.65	33.3
3	18.7	1.7	6.1	21.4	35.6	0.97	0.47	0.40	1.53	29.2
4	18.5	1.2	6.4	23.8	35.4	0.94	0.44	0.48	1.69	30.8
5	21.6	1.7	4.7	18.2	35.0	0.94	0.50	0.45	2.00	39.3
6	17.8	1.9	5.1	25.0	34.3	0.74	0.47	0.28	1.52	34.4
7	19.7	1.5	5.0	18.5	33.6	0.98	0.43	0.51	1.58	26.4

Key Words: TMR, Forages, Chemical Composition

506 Nutrient intake and body characteristics of dairy cows in Washington state dairy herds producing in excess of 12,730 kg of milk annually. L. M. Johnson*¹, J. H. Harrison¹, W. Schager¹, D. Davidson¹, S. Chen², C. Stockle², F. Hoisington³, and C. A. Rotz⁴, ¹Washington State University, Puyallup, WA, ²Washington State University, Pullman, WA, ³Dari-Tech Services, Kent, WA, ⁴USDA-ARS, University Park, PA.

Seven Holstein dairy herds producing greater than 12,730 kg of milk annually were selected to characterize animal factors related to high milk production. Six herds used BST, one herd milked 2x, five herds milked 3x, and one herd milked 4x per day. In each herd the top mature cow string was measured for body characteristics and intake of nutrients. Other parameters that were measured included the number of cows in a string, DIM, milk production, and physical effectiveness of the diet (DM on two sieves of NASCO's® Particle Separator). Body weight was within 20 kg between herds, except for Farm 3, where the cows were giving more milk and weighed 50 to 70 kg less than the other herds in this study. The majority of the herds had DMI greater than 25 kg/day. Starch intake ranged from 4.1 to 6.8 kg/day, NDF intake ranged from 7.7 to 9.3 kg/day, and CP intake ranged from 4.6 to 5.3 kg/day. These results indicate that the level of starch and NDF in the diet can vary, and high levels of milk production can still be achieved. Physical effective fiber ranged from 44 to 76%, and physical effective NDF ranged from 15 to 27%. A minimum physical effective NDF intake of 20% of ration DM was recommended for lactating dairy cows.

Farm	No. Cows	DIM	Milk kg	Body Wt. kg	Wither Ht. cm	Length to Pins cm	DMI kg	Physi- cal Effect Fiber %	Physi- cal Effect NDF, %
1	58	100	49.5	652	...	...	25.7	...	...
2	80	266	46.4	657	...	...	25.5	76.1	26.9
3	119	125	50.5	604	143	95	26.5	67.9	24.2
4	109	132	49.1	670	143	102	25.0	71.1	25.2
5	87	117	49.1	657	142	99	22.8	60.0	21.0
6	128	91	45.5	654	142	97	27.1	44.2	15.2
7	98	135	41.6	668	141	102	26.7	52.0	17.5

Key Words: Milk Production, Intake, Body Characteristics

ASAS/ADSA Teaching Undergraduate and Graduate Education and PSA Extension and Instruction: Teaching I

507 Poultry science student recruitment through teacher and counselor education. R.J. Lien, J.B. Hess*, R.A. Voitle, J.P. Blake, D.E. Conner, and W.D. Berry, *Auburn University, Auburn, AL 36849-5416.*

University poultry science student recruitment is vital to the long-term success of the poultry industry and the survival of university poultry science programs. Conservative estimates indicate that universities in the Southern U.S. are only able to fill 20-30% of the annual regional need for poultry science graduates in the poultry industry. Efforts by the U.S. Poultry and Egg Association and university poultry science programs are attempting to spread the message of job opportunities to potential high school and junior college students. Auburn University's Poultry Science Department instituted a Teacher/Counselor Education Program in 1995 in an attempt to reach more prospective students. Initial efforts were targeted at teachers and guidance counselors that had placed students with Poultry Science in the past. Subsequent efforts have drawn participants from state-wide mailings to all high school science and agribusiness teachers and counselors, and advertisements in counselor and science teacher association newsletters. Enrollment for the 1.5-day course (all expenses paid on campus) has averaged 20/year, with the majority of participants attending from schools in areas of poultry concentration. Continuing education credits are offered. Topics covered include Alabama and U.S. poultry industries, educational opportunities, departmental and college scholarships, job opportunities and veterinary school options. Average enrollments in the department have been 40% higher since the inception of this program.

Key Words: Student Recruitment, Undergraduate Teaching, Continuing Education

508 A paradigm to increase student enrollment in animal science courses and fulfill educational expectations. Darrel J. Kesler*¹, ¹*Department of Animal Sciences, University of Illinois.*

Projections that intensification of animal production is decreasing the need for animal scientists that could lead to the demise of the animal science profession (Cheeke, J. Anim. Sci. 77:2031; Letters to the Editor, J. Anim. Sci. 78:1691) have either generated concern, with little action, or are rejected. In an attempt to avoid the projection, I have developed and implemented a paradigm to increase student enrollment in animal science courses and the fulfill educational expectations of our new generation of animal science students. The first step was to reinvent an existing course, now titled Biology of Reproduction (AnSci/Biol 231). This involved changing a more traditional farm animal reproduction course to be more inclusive of all species, including humans (Kesler, NACTA J. 44[3]:11). The course was designed to fulfill general education requirements in natural sciences and was cross-listed in Biology. The second phase was the creation of a discovery course (AnSci 110), Life with Animals and Biotechnology, that approached the discipline in a non-traditional manner (Kesler, J. Anim. Sci. 75:273). It began as a 1-credit hour course but has been revised to a 3-credit hour course that fulfills general education requirements in natural sciences. The third phase involved instruction on nontraditional animal careers. Although this phase is incomplete, a traditional spring trip course was modified the past two spring semesters where students were introduced to biomedical industries with animal related careers. Student enrollment in AnSci 110 and 231 increased ($r=.99$; $P<.01$) from 66 in year 1 to 212 in year 7. Course quality evaluation ratings also increased ($r=.94$; $P<.01$) and

paralleled ($r=.95$; $P<.01$) the increase in enrollment. Although the average class size (department enrollment 4 classes) also increased, course enrollment in AnSci 110 and 231 increased at a greater rate (3.5 times greater) increasing instructional units credited to animal science. The major reason for the increase was non-majors (41% of the students were non-majors this past year; $r=.98$ [$P<.01$]; non-majors were primarily from outside the college) enrolling in the course. Therefore, animal science can remain as a viable discipline; however, revision may be appropriate even if the pessimistic projection is wrong.

Key Words: Teaching, Course Enrollment, Undergraduate Education

509 A model for choosing instructional strategies to support distance education students. A.M. Shorridge and J.L. Emmert*, *University of Arkansas.*

The Department of Poultry Science at the University of Arkansas has developed web-based distance education courses in poultry science that include Broiler and Turkey Production and Breeder and Layer Management. Although the use of the Internet to teach university curricula is commonplace, few guidelines have been published to support course authors as they attempt to move their teaching out of the traditional classroom and into cyberspace. In an effort assure the quality of the courseware produced for this project we conducted an examination of current instructional design models, distance education and learning theories, the use of media in education, and available web-based distance education courses. The results indicated that most university level courses currently offered are limited in that they are not grounded upon an appropriate learning theory that is able to provide interactive instructional strategies. Results also indicated that the interactive component of web-based distance courseware could be increased substantially by the use of concept mapping within a human constructivist framework. Our next objective was to evaluate the integration of concept mapping into web-based distance education courseware as a tool to increase interactivity and learning outcomes. Students in traditional poultry production courses were provided with videotaped concept mapping instructions similar to what would be available on the Internet. Concept mapping assignments were then given before and after course modules were presented to allow comparison of pre- and post-maps. A blend of qualitative methods, including document analysis, observation, concept mapping and interviewing were used to probe a real-life context within a unique case orientation. This study also made use of data triangulation and investigator triangulation to establish credibility of the findings. Data indicate that concept mapping may be utilized successfully within web-based distance education courseware as a tool to enhance interactivity and establish effective pedagogy.

Key Words: Distance education, poultry production, concept mapping

510 Technology enhanced instruction: Incorporating Internet activities into a poultry products course. T. J. Buttles*¹ and B. S. Walters², ¹*University of Minnesota, St. Paul, MN,* ²*University of Wisconsin - River Falls, River Falls, WI.*

The Internet is changing many aspects of our culture, including classroom instruction. Internet tools and resources have been added to the list of instructional methods available to teachers. Several different types of Internet based activities have been incorporated into the poultry products technology course offered as part of the Midwest Poultry

Consortium sponsored Undergraduate Poultry Science Center of Excellence summer program. Students were required to find and critique poultry products related articles on the Internet as well as in print media. Students also used the Internet to submit selected assignments. WebCT, a package of web based course tools, was also utilized as part of the instruction in this course. Computer based instruction modules were developed for a small portion of the course content. These modules supplemented classroom and lab instruction, allowing students to control the speed and direction of instruction. Links to Internet resources were embedded into the lessons, with several lessons requiring students to visit specific websites to complete the activities. Several quizzes were also given with WebCT. This form of delivery allowed students to take the quiz when they felt ready for it and also provided immediate feedback on the answers to objective type questions. WebCT was also used to provide electronic backup copies of the syllabus and assignment sheets that students could access at any time. Finally, WebCT was used to provide students with access their individual grades. The instructors were able to put the grades into the WebCT system immediately following the completion of the course, as compared to the several weeks it took for official grades to make it into the campus system. Overall, these Internet activities provided an additional way for students to learn course material, be assessed on their learning, and interact with course instructors. While they will never replace even a majority of the classroom and laboratory instruction in this course, Internet activities did provide one more tool for instructors to try and provide appropriate learning activities for a diverse range of students.

Key Words: Instruction, Teaching, Internet, Midwest Poultry Consortium

511 Assessment of students' access of world wide web course material posting in small class size. M. A. Wattiaux* and K. Kanwar, *University of Wisconsin, Madison*.

Our objective was to use the student-tracking feature of an electronic course delivery package (Webct) to monitor students' access of course-related material posted on the world wide web and to correlate web usage with final grade. The study was conducted in a two-credit ruminant nutrition course including 19 juniors or seniors and four graduate students. At the beginning of the semester, the posted material included a 700-word glossary and three modules. Each module included 15-20 slides with instructor/s notes, a study guide and assignments. Weekly additions to the site included primarily lecture slides (without instructor/s notes or study guide) and assignments. Students' access to the web was recommended, but optional because course modules were covered in lectures and discussion sessions. Number of HTML pages accessed by each student was recorded weekly. Seventy-eight percent of the students accessed the site for the first time within two days of its announcement, but one student did not access the site until 20 days into the semester. The first three modules were covered by the end of the first two weeks of class, and the average number of hits per student (HPS) was then 96 (range 0 to 243). Henceforth, HPS declined sharply and averaged 6.8 (range 0 to 13) per week over the remaining part of the semester. Discrete events associated with a rise in weekly HPS included taking time in class to show the web (week 5; HPS = 12) and posting of the previous year/s mid-term exam (week 10; HPS = 13). Posting of lecture slides alone did not attract students' attention. At the end of the semester, total HPS averaged 177 (range 30 to 658). Non-parametric, Spearman correlation indicated that HPS after the first week of class was a good predictor of HPS at the end of class ($r = .88, P < .001$). There was no correlation ($r = .27, P > .05$) between total HPS and final grade. In small class size, students' intrinsic motivation for the course may be a major determinant of web usage.

Key Words: Instructional technology, Undergraduate learning, Internet

512 Use of Trans Texas Video Network for graduate education between Texas A&M University System and Texas Tech University. L. W. Greene*¹ and C. R. Richardson², ¹Texas A&M University System, Amarillo, ²Texas Tech University, Lubbock.

A minerals and vitamins animal nutrition lecture class was developed and taught to students in the Texas A&M University (TAMU) System and Texas Tech University (TTU) for three consecutive yr via Trans Texas Videoconference Network (TTVN). The TTVN is an interactive media for lecture delivery. TTVN is a statewide videoconferencing system at TAMUS locations, TTU and other state agency offices. The

system provides a two-way multipoint digital video conferencing and data transmission service. Universities, extension services, public service agencies and research organizations fund the system. The class has been taught at TAMU-College Station (yr 1, 2), WTAMU-Canyon (yr 1, 2, 3), TTU-Lubbock (yr 1, 2, 3), TAMU-AREC-Amarillo (yr 1, 2, 3) and TAMU-Kingsville (yr 2). Student enrollment for yr 1, 2 and 3 was 26, 20 and 9, respectively. Students enroll and obtain credit for the class at their home institution. The mineral section originates from TAMU, Agricultural Research and Extension Center, Amarillo (Greene) and the vitamin section originates from TTU at Lubbock (Richardson). Each section of the class consists of 12 to 13, 80 to 90 min lectures. Lecture notes and related course information were developed with the same style and form, and published on the internet. Students are graded based upon their performance on written test and term papers. Grades from each section are weighted equally for calculation of final grades. Open-book exams and papers are e-mailed by the students to the instructor for grading. A proctor (local faculty member) is assigned at each location to supervise closed-book exams, and mailing exams to the instructor. Outside of class, students communicate with instructors, and turn in term papers and open-book exams via e-mail. Questions and answers are also handled during interactive class time on TTVN. This class provides students at several locations the opportunity of taking a minerals and vitamins animal nutrition class.

Key Words: mineral/vitamin nutrition, classroom instruction, distance education

513 Teaching Animal Nutrition online. P.A. Schoknecht*¹ and H.D. Hafs², ¹University of Richmond, ²Rutgers, The State University of New Jersey.

Web-based distance education has the potential to expand course offerings and/or conserve teaching resources. During the Fall of 2000, the lecture (3 credits) of Rutgers Animal Nutrition was offered online (instructor in VA) to 94 students in NJ. Students also attended a resident laboratory section (1 credit). The distribution of grades was comparable to the previous 3 years when the same instructor taught the course in residence, suggesting that student learning was not impaired. A survey completed by 85 students provided the following data. Online learning was entirely new for 98% of the students and the course was required for 92%. 93% of the students felt they had sufficient access to both a computer and an Internet connection, with 39% of those living in networked university housing, 26% using a modem, 21% using both a modem and university computer labs and 14% using only the computer labs. While 70% of the students felt they had too little interaction with the instructor, only 52% of the students ever emailed the instructor outside of the required homework assignments and only 24% of those emails pertained to course material. When given the opportunity to post questions to a website, students posted none. Instructor postings were read by only about 10 students unless the posting had to do with an exam. The aspects of the online course that students liked the most were that they were able to work at their own pace (36%), did not have to attend lecture (22%), had detailed notes (16%), and the studying was interactive (16%). On the other hand, they missed interactions with the instructor (50%), felt they had problems learning (28%), and had computer problems (22%). The majority of students were not prepared for the self-discipline and initiative required for an online course. In overview, despite the difficulties, students not only learned animal nutrition effectively they also learned about self-directed studying and time management. While many students were uncomfortable, they may have been well-served by being forced to learn these skills, as 75% reported they are now better prepared to take future online courses.

Key Words: Distance Education, Undergraduate Education, Web-based Teaching

514 Development of a capstone course in dairy herd management. D. K. Combs*, G. E. Shook, and M. C. Wiltbank, *University of Wisconsin-Madison*.

During the last 8 years we have developed a three credit course that is designed around troubleshooting nutrition, genetics, reproduction, and milk quality on commercial dairy farms. Early in the semester, class-room activities center on discussion and case studies that utilize principles of Total Quality Management (TQM) to assess processes and critical control points on dairy farms. In the first month, pairs of students are teamed with a nutrition consultant who identifies a farm for

the students. Farms are selected by the consultant and faculty based on availability of records, interest of the dairy producer, and nature of the management issues likely to be encountered. The students and consultant form a working team, and make the initial farm visit together. Students arrange subsequent farm visits directly with the producer. By mid semester, students present a written report and an oral presentation to the class that gives an in-depth evaluation of each of the four disciplines for the farm they are working on. The consultant, fellow students, and faculty critique the student's farm evaluation. Discussion after the mid-term presentation helps students select a key issue that appears to be most limiting on their farm. Issues addressed by students have included: nutritional metabolic disorders, forage quality, business plans for anticipated expansions, reducing somatic cell counts, and reducing calving intervals. At the end of the semester, the students generate a letter to the producer and give a final oral presentation to the class, producer, and faculty that analyzes critical data on the current situation, possible new strategies, and estimated economic consequences. The consultant, producer, fellow students, and faculty evaluate the presentation and plan. Consultants involved with the course have been enthusiastic about participating again. Detailed student evaluations of the course have been very positive. The TQM approach has helped to focus students on actual data and production processes rather than stereotyped solutions. The use of a team of students, consultants, and farmers to bring current farm cases back to the class has allowed more in-depth analysis of multiple farms than visits to farms by the entire class.

Key Words: Teaching, Dairy management, Total quality management

515 Practical Broiler Production - A hands-on approach to student learning. J. C. Hermes*¹, ¹Oregon State University, Corvallis, OR.

Classroom teaching in a lecture format has been the traditional method of teaching of undergraduate students. This method is used for most of an undergraduate's credit load for courses as diverse as American History, English Literature, Biochemistry, Genetics, and Poultry production. To enhance student learning, some courses have a laboratory section which may or may not be required. In some instances, laboratories may or may not give students a sense of the "real world" with real questions to investigate or they may be simply show and tell. We know that students learn best by doing, and many students prefer a hands-on approach to learning compared to the traditional lecture format. To address student interest we have developed "Practical Broiler Production," a completely hands-on course to teach not only the science but also the art of producing poultry meat.

Beginning with a student suggestion, we began a completely hands-on educational experience for our students. Partnering with local industry groups, companies, and individual broiler producers, donations of money and equipment were raised to retrofit an underused poultry research building into a typical broiler house. With the generous support of Foster Farms, our facility is currently a contract producer of about 4600 broilers each term. Students are the growers, making management decisions and learning in the "real world", an experience that can be compared with an industry internship. It is our hope that because of the hands-on nature of this course, our students will be better prepared to move from their academic experience into industry by increasing their credibility with company representatives and producers.

Key Words: Teaching, Broiler production, Hands-on education

516 Oregon State University's Steer-A-Year program: integrating classroom learning and hands on experience. C. J. Ackerman*, D.W. Weber, and R. L. Dickson, Oregon State University, Corvallis, OR.

The Steer-A-Year course is designed to provide classroom and hands-on experience, industry-student interaction, and student group problem-solving opportunities. It is a cooperative agreement between the Department of Animal Sciences and the Oregon Cattlemen and Cattlewomen's Associations. Steers are donated to the program by beef producers, fed a high concentrate ration to a target BW and condition, and marketed as either carcass or retail beef. After feed and management expenses are deducted, the Department of Animal Sciences distributes one-half of the profit towards beef facilities improvements and the other half is distributed to the donor's choice of either the Oregon Cattlemen or Cattlewomen's Association. Approximately 30 steers have been donated to the program annually each of the past eight years. The donor receives

regular updates regarding steer performance during the feeding period and carcass data following harvest of the animal. Students and instructors feed and manage the steers. The instructor uses classroom time to provide information to enable students to make informed management decisions. Officers are elected from within the class each term. Student officers are responsible for ensuring that cattle are managed and fed appropriately and they lead the class in putting together and sending out regular producer updates. A facet of the class that is evolving is in the area of processing and marketing. Steers are sold locally through the Animal Sciences Meats Lab. Students are encouraged to participate in a separate course in which they process the steers into retail product. In this manner, students in the project have the opportunity to be involved in procurement, management, processing, and marketing. The course is challenging for the instructor as it requires management of lecture material, cattle health and feeding, producer and employee rapport, and student participation to ensure annual success of the program in terms of student learning and public relations. The course is very well received by students, most of whom have labeled it as a great learning experience.

Key Words: Cattle, Beef, Finishing

517 Quantification of learning in animal nutrition: An assessment of teaching. R. S. Kensinger*, Penn State University.

Institutions of higher education are in an era of greater scrutiny with regard to the use of public funds. Teaching programs in Universities should be both creative and rigorous in nature. In order to achieve this goal, there is a need to develop methods that better quantify the quality of instruction. A method of evaluation was used to evaluate teaching of an introductory course in animal nutrition. The method used a simple examination that was given, unannounced, on both the first and last day of class. The examination included only 20 questions, required less than 10 minutes to complete, and was used to evaluate acquisition of information. All students were informed that the exam had no bearing on their grade for the class. Over 400 students have participated in use of this evaluation tool. Mean class performance on pre-exams has been 7.1/20 compared to mean of 13.4/20 on the post-exam ($P < .01$) demonstrating significant acquisition of information. Data from this exercise show that previous knowledge is important, as there were significant positive correlations between pre-examination score and final class average ($r = .416$ to $.543$, depending upon the semester, $P < .01$). Furthermore post-examination score was a very good predictor of final class average, as correlations range from $.660$ to $.678$ (all $P < .01$). The few students (about 1%) who did not show significant improvement were characterized by poor attendance, or problems with their attitude about the course; which had been documented prior to completion of the semester. It was concluded that this simple tool could be used to quantify learning in the classroom. It could be useful to evaluate instructional approaches used by the instructor. It places the emphasis on the student rather than the instructor, and it has demonstrated that learning is an incremental process.

Key Words: Teaching, Evaluation, Animal nutrition

518 An integrative approach to teaching advanced undergraduate non-ruminant animal nutrition. N. L. Trottier* and J. Perez-Laspiur, Michigan State University.

With the growing number of undergraduate students in the animal science field, it is becoming increasingly challenging to teach courses that supply both theoretical and applied based knowledge. In addition, it is a concern of both faculty and industry that animal science students graduating with a nutrition emphasis may not possess sufficient applied based knowledge across farm animal species. A non-ruminant animal nutrition course for advanced undergraduate students has been developed at Michigan State University to enhance application in nutritional diversity. While 75% of the students have equine interests, the course covers three major species categories, i.e. swine, poultry, and equine, with equal emphasis. Each laboratory (lab) category utilizes the same lab format. Week one is devoted to teaching and discussing feed ingredients and nutrient requirements for the species in question via the web based National Research Council. The second week focuses on teaching diet formulation using manual techniques, computer based programs and models. The lab practicum (prac) is conducted during the third and fourth week. Students learn to allocate animals to different experimental

diets, collect biological samples, and record data. During the fifth week, a group discussion of the results is conducted. Students are responsible for retrieving the lab information and the compiled data from the web prior to participating in the discussion. The swine lab consists of evaluating the effect of fat supplementation on lactational performance and milk composition in lactating sows. The objective of the poultry lab is to evaluate the effect of feeding diets deficient methionine concentration on egg production in laying hens. The poultry lab prac is conducted over a 10-day period. The equine lab consists of testing the effect of feeding a legume hay versus a grass hay on the nitrogen balance of the horse. Students work in groups of four, and rotate every 6 hours over a 5-day collection period. Students are required to submit a complete report for each lab category. The lab report is written following a guideline provided on the web. Reports must integrate the knowledge gained from diet formulation and lab prac results, and theory learned in class.

Key Words: Nutrition, Laboratory, Teaching

519 Utilization of small-group special species projects to facilitate undergraduate applied animal nutrition learning experiences. J.R. Carpenter*, *University of Hawai'i at Manoa, Honolulu, HI USA.*

Over the past five years, the use of a small group "Special Species Project" has been adopted as a major learning component for our undergraduate applied animal nutrition course. This philosophy was adopted to assist students in: 1) addressing the desired CTAHR graduation competencies, 2) fulfilling their writing intensive course requirements, 3)

PSA Environment and Management: Composite Group

520 Interaction of feeding program and space on broiler breeder egg production. J. Brake*, *North Carolina State University, Raleigh, NC USA.*

Broiler breeder pullets (Cobb 500 FS) were placed in 12 pens, each of which contained 12 Kuhl DH-4 38 cm (15-inch) diameter feeders. There were 19 pullets per pan in all pens to 14 weeks of age. Density was 6.9 birds per square meter. Pullets were randomly removed from all pens at 14 weeks of age to achieve either 15 or 18 pullets per pan to 22 weeks of age. This gave densities of 5.4 or 6.4 birds per square meter. During the rearing period pullets were fed on either a Low, Medium, or High program that provided 24,240 kcal ME and 1296 g CP, 26,020 kcal ME and 1391 g CP, or 27,780 kcal ME and 1485 g CP, respectively, at 21 weeks of age. With the exception of space, feeding and management were identical among the treatments following movement to breeding quarters and photostimulation at 22 weeks of age. Early egg production responded positively in a dose-related manner to feeding program but no overall difference was observed due to space. Inspection of the interaction revealed little effect of space on the High or Low programs but an obvious improvement in egg production due to more space on the Medium program. These data suggest that space has little effect when all pullets are nutrient deficient (Low) or nutrient replete (High) but has a measurable effect on egg production when cumulative nutrition is marginal.

Key Words: Feeder Space, Floor Space, Density

521 Early protein intake influences long term egg production by broiler breeder hens. R.J. Lien*, J.B. Hess, and W.D. Berry, *Auburn University, Auburn, AL.*

A total of 800 Cobb 500 strain broiler breeder hens provided either high or low protein intake to 4 wk of age were subsequently provided equal allotments of the same feeds through 65 wk to determine long term effects on egg production. Feeds containing 2860 Kcal ME/kg and either 19(high) or 15%(low) CP were provided *ad libitum* to 2 wk, in limited daily allotments to 3 wk, and in limited allotments on 4 of 7 d/wk during wk 4. Allotments were adjusted so total feed intake to 4 wk was 0.95 kg/bird in both trts. This resulted in total CP intakes to 4 wk of 142g (low) and 180g (high). Equal allotments of a 15% CP developer feed were provided both groups on 4 of 7 d/wk from 4 to 21 wk and daily from 21 to 23 wk. A photoschedule of 8h L:16h D was provided to 21 wk and 15h L:9h D was provided from 21 to 65 wk. Peak feed allotments of 159 g/hen/d were provided from 29 to 32 wk. Allotments were then decreased 4.0 g/hen/wk for 2 wk, and 0.9 g/hen/wk thereafter. At

developing their interpersonal and communication skills by working in small groups of 2 or 3, 4) developing research and problem-solving abilities, 5) applying principles of ration balancing, 6) enhancing computer skills and use of computers in diet formulation, and 7) improving public speaking skills. Because of the intensity of the course and the small class size (only 20 students), it has been very successful during the brief time it has been implemented. The class has encompassed the following species: equine, bovine, ovine, caprine, avian, porcine, canine, feline (both companion and exotic), marine mammals (dolphin and monk seal), and various aquatic species (both carnivorous and herbivorous fish and crustaceans). Since the students are involved in species assignment, there is genuine interest, increased energy, enthusiasm, and the desire to learn. So many undergraduates are raised in urban settings, lacking the practical experiences and exposure to animal production and companion/zoo-related industries, their feeding programs and specialized equipment/facilities. Students contact industry and community representatives and become aware of the diversity of animal nutrition as a career. In the course, students are also exposed to critical review of scientific journal articles and the use of the internet, popular press, and other sources of information as resources. They frequently express appreciation for the practical application of principles and special skills learned in previous lectures/labs. Although much of the effort is guided, there still is flexibility for the students to complete requirements within the semester time constraints. Challenges of the course will also be discussed.

Key Words: Small group active-learning, Applied animal nutrition, Instruction

4 wk, BW of high and low CP trts were 577 and 540 g, respectively. However, BW of the 2 trts did not differ from 9 to 65 wk. At 65 wk, mean BW was 3.87 kg. Feed consumption rate was greater in the high trt at 4, 6 and 8, but not 10 wk. Bone in breast wt, shank and keel length, and carcass moisture, CP and ash were all greater in the high trt at 4 wk. Fat pad wt and carcass fat were greater in the low trt at 4 wk. There were no differences in carcass composition at 21 or 30 wk. Uniformity was greater in the high trt at 4 wk; however, no differences were seen at 21, 25 or 30 wk. Age at onset of lay did not differ between trt. Total egg production/hen at 65 wk were 157 and 141 in the high and low treatments, respectively. Egg production did not differ between trt from 25 to 35 wk. However, from 36 to 45, 46 to 55, and 56 to 65 wk, egg production/hen in the low trt was reduced by approximately 4, 5 and 5 eggs, respectively. Egg wt and specific gravities did not differ between trt. Increased early CP intake had no measureable long term effects on BW or carcass composition, but resulted in greater post-peak and total egg production by breeder hens.

Key Words: Broiler Breeder, Protein Intake, Egg Production

522 Body weight management and performance of broiler breeder males. Wallace Berry*¹, Pingbo Liu¹, Haitao Li¹, and Alex Peterson¹, ¹*Auburn University Department of Poultry Science.*

Complex feeding programs for broiler breeders require intensive management. Underestimation of feed allotments can permanently damaging fertility. To avoid this, males are often allowed to become too large. One possible strategy to reduce these risks is to restrict growth early to keep the birds below the usual body weight targets while still allowing growth. This would provide an increased margin of error between actual growth and the desired growth targets. To test this strategy, male chicks in the Small group were full fed standard 22% broiler starter until they reached 1.2 lbs average body weight. Chicks in the Large group were full fed starter until they reached 1.9 lbs body weight. When the chicks in each group reached target body weight, they were switched to a 12% protein rearing diet and fed to maintain positive growth rates and body weight divergence through week 21. At 21 weeks of age, the male birds were placed with females in pens in a curtain sided, slat/litter breeder house. The ratio of females to males was 10:1. Lighting schedule was arranged to provide 14 hours of light with an increase of 15 minutes of light each week to a maximum of 16 hours light. Body weights were measured every 4 weeks. Weekly fertility was monitored by breakout of eggs following 7 days of incubation. Every fourth week eggs were incubated to

hatch to determine hatchability and embryonic mortality. Small males were 1.25 lbs at week 3, 5.5 lbs at photostimulation, 8.5 lbs at peak, and 9.75 lbs at week 45. Large males were 1.9 lbs at 3 weeks, 7 lbs at photostimulation, 9.75 lbs at peak, and 11.2 lbs at week 45. Weight uniformity at 21 weeks of age was 84% for the small males and 85% for the large males. Small males suffered less culling and mortality than large males (22% vs. 30%). Small males gave an overall mean fertility rate of 97.75 % as compared to 96.6% for the Large males with the greatest differences occurring before and after peak production. Differences in embryonic mortality were slight. The results of this study indicate that heavy breeder males can be maintained at body weights below guideline recommendations, but with continued growth, up to peak production without adversely affecting fertility and hatchability.

Key Words: Breeder, Body weight, Fertility

523 The effects of feeding different levels of protein with and without the DFM, Primalac, on production parameters of bobwhite quail. G. S. Davis^{*1} and L. R. Minear², ¹NC State University, Raleigh, NC USA, ²Southern States Cooperative, Providence Forge, VA USA.

The Bobwhite quail (BQ) is an upland wild gamebird in the USA, and its numbers have declined approximately 80% in the wild during the past 40 years. Consequently, 20,000,000 BQ are produced each year with the majority of these birds being raised and released on commercial hunting preserves. Producers of BQ typically experience high mortality during the rearing period. However, previous research has shown that adding PrimaLac (P), a Direct-Fed Microbial (DFM), to the diet significantly reduced BQ mortality and improved body weight (BW) gain and feed efficiency (FE). There is very little information regarding the dietary protein requirements of BQ. Therefore, a study was conducted to examine production parameters of BQ provided different levels of dietary protein (DP) with and without P from 1 d to 10 wk of age. 720 BQ were divided into 8 Trt groups and randomly placed into 6 replications each. A 2 X 2 factorial arrangement of Trts with 4 DP levels and 2 P levels (0 and 2 lbs/ton feed) consisted of the following dietary regimens: Trt 1=28% DP starter for 5 wk and 24% developer for 5 wk; Trt 2=26% DP starter for 5 wk and 20% DP developer for 5 wk; Trt 3=28% DP starter for 10 wk; Trt 4=30% DP starter for 2 wk and 26% DP developer for 8 wk; Trt 5=Trt 1+P; Trt 6=Trt 2+P; Trt 7=Trt 3+P; Trt 8=Trt 4+P). Livability was enhanced by the DFM during the first 2 wk. BQ fed 28% and 30% DP with P exhibited consistently heavier BW from 6 to 10 wk. Cumulative FE at 10 wk was improved in the DFM Trts (5.28) compared to BQ with 0 DFM (5.30). BQ feather score at 10 wk in the DFM Trts (6.75) was greater than that of the 0 DFM Trts (4.6). It was concluded that dietary P can enhance livability, BW, and feather score in BQ.

Key Words: Bobwhite quail, DFM

524 Effect of Acute Heat Stress on Some Productive and Physiological Traits of Bronze Turkey. Talat, M. El-Sheikh^{*1} and Mordy, A. Kalamah², ¹South Valley University, Faculty of Agriculture, Sohag, Egypt, ²Menofia University, Faculty of Agriculture, Menofia, Egypt.

The objective of this study was to investigate the effect of acute heat stress on physiological and productive traits of the Bronze turkey. One hundred and two Bronze turkey at 10 weeks of age were divided into three treatments and placed in climate chambers at 45C and 40% RH (heat stress) for two hours, the first and second groups were exposed for two and three times weekly and the third group reserved as control. Birds were given feed and water ad libitum and weighed biweekly from 10 to 32 weeks of age. Body temperature, respiration rate were measured weekly per bird before and after heat stress. Semen quality and blood constituents were measured at 12, 20 and 28 weeks of age after exposure of heat stress. The results revealed that the high temperature caused significant reduction in body weight and growth rate. Respiration rate and body temperature were significantly ($P<0.01$) higher in birds exposed to heat stress than those in control. The toms exposed to heat stress had significantly lower sperm motility, concentration ($P<0.01$), and live and abnormal sperm ($P<0.05$) than control toms. However, ejaculate volume and semen pH were not significant. Heat stress caused significant reduction in plasma total protein, albumin globulin, total lipids, calcium and inorganic phosphorus, creatinine, T4, growth hormone ($P<0.01$), and T3 ($P<0.05$) of birds. However plasma cholesterol

and alkaline phosphatase did not differ between birds exposed to heat stress and control.

Key Words: Bronze turkey, Heat stress, Productive traits, Physiological parameters

525 Effect of dietary diacetoxyscirpenol and fusaric acid on turkey poult performance. A.S. Fairchild^{*1}, J.L. Grimes¹, J.K. Porter², W.J. Croom¹, L.R. Daniel¹, and W.M. Haggler, Jr.¹, ¹North Carolina State University, Raleigh, NC USA, ²R.B. Russell Agricultural Research Center, USDA/ARS, Athens, GA USA.

Effects of dietary diacetoxyscirpenol and fusaric acid were determined on day-old turkey poults by randomly placing poults in batteries and feeding them one of four dietary treatments: control (C); control plus 4ppm diacetoxyscirpenol (DAS); control plus 300ppm fusaric acid (FA); and control plus 4ppm DAS and 300ppm FA (DF). There were 10 poults per pen with 6 replicate pens per treatment. Individual BW, BW gains (BWG) and pen feed consumption were determined at d6, 12, and 18. Period and cumulative feed gain was calculated. Relative liver, spleen, bursa, intestine, and jejunum weights were measured at d18. Mouth lesions were scored for treatments at d18. Performance parameters were regressed on treatment means using the GLM Procedure of SAS[®]. Means were separated using LSMEANS with significance level set at $P\leq 0.05$. FA had no effect on BW or BWG at any period compared to C. Poults fed DF had reduced BW and BWG compared to C, while poults fed DAS had lower BW than all treatments at every period. Final BW were: C (451.7g), FA (464.9g), DF (389.0g), and DAS (351.4g). Poults fed FA or C had better feed to gain than poults fed DAS or DF (1.05 and 1.04 vs. 1.19 and 1.15, respectively) at d6. However, the effect of FA was transient: there were no differences among the treatments at d12 or d18. Poults fed FA had significantly lower relative intestine wt than poults fed other diets, and had significantly higher relative bursa wt at d18 when compared to poults fed DAS or DF. Poults fed DAS or DF had higher mouth lesion scores than poults fed FA or C, but mouth lesion scores in DAS and DF poults were not different from each other (4.48 vs. 4.64). In conclusion, dietary DAS resulted in decreased poult performance, while dietary FA had little or no effect. However, FA fed in combination with DAS resulted in some protective effect towards DAS.

Key Words: Diacetoxyscirpenol, Fusaric acid, Turkey

526 The effect of a biological litter treatment on microbiological litter quality in turkey breeder flocks. T. Wiard^{*1}, M. Gockley¹, G. Troyer², and T. Rehberger¹, ¹Agtech Products, Inc., Waukesha, WI, ²Willmar Poultry Co., Willmar, MN.

A study was conducted to determine the effects of a biological litter treatment on the quality of litter in turkey breeder flocks. A flock of breeder hens were moved from a brooder barn at five weeks of age and divided into two grower barns. One barn was used as a control barn with no biological litter treatment applied, while the second barn was treated with a biological litter treatment. At twenty-eight weeks of age hens from the control grower barn were moved into two layer control barns, and hens from the treated grower were moved into two treated layer barns. In both facilities, the litter treatment was reapplied to the treated barns every ten weeks. Biweekly litter samples were taken and serial dilutions were used to enumerate total gram-negatives, coliforms, and *E. coli* found in the litter. Additionally, monthly drag swabs were collected and used to determine the presence of *Salmonella* in each barn. In the grower phase, total gram-negative bacteria in the litter were reduced by 65%, coliforms by 69.5%, and *E. coli* by 6.3% in the treated barn compared to the control barn. In the grower barn, the initial *Salmonella* drag swab samples for both the treated and control barns were negative. In the control barns, the number of positive *Salmonella* samples rose to 60% by the second sampling, and to 80% by the third sampling, where they remained until the birds were moved out of the grower barns. During the same time period, *Salmonella* remained at an undetectable level in the treated barn. In the initial drag swab samples from the layer barns, only one sample was positive for *Salmonella* in the treated barns compared with three positive samples from the control barns. By the eleventh week in the layer barns, 40% of the samples tested positive for *Salmonella* in the control barns, while *Salmonella* was at an undetectable level in the treated barns. The biological litter treatment was effective in controlling the number of total

gram-negatives, coliforms, *E. coli*, and *Salmonella* present in litter from turkey breeder flocks.

Key Words: Turkey, Litter, *Salmonella*

527 Sex differences in some hatching parameters. Akrum Hamdy*, *Animal Prod., Dept., Fac., of Agric., Minia Univ., Egypt.*

One thousand and hundred fertile eggs of Hisex Brown layers were used in this study. Variations in hatching time as affected by egg size and their subsequent effect on hatch weight, placement weight and sex ratio were evaluated. Egg weight had a positive correlation coefficient with hatch weight and placement weight (0.664 and 0.656, respectively). While it has a negative value with hatching time (-0.602). Female chicks tend to hatch earlier than males. About 71% of females had hatched by 506 hrs. whereas 55% of the males had hatched at a comparable time. Greater weight loss in females than males may be due to evaporation, which occurred in the hatcher. From these results, it may be advantageous to develop procedures for harvesting female chicks more than one time during the hatching period.

Key Words: Sex Differences, Hatching Time, Egg Size

528 Real time incubation temperature control and heat production of broiler eggs. R. M. Hulet*¹ and R. Meijerhof², ¹*Pennsylvania State University, University Park, PA,* ²*Hybro BV, Boxmeer, NL.*

Previous research has shown the value of controlling heat production during incubation for high-meat yielding broiler eggs. The purpose of this study was to evaluate the effect of maximizing heat production from five to eighteen days of incubation on hatchability and embryonic mortality. Two trials were conducted using 115,200 eggs from broiler breeders between 42 and 45 weeks of age (Lagerwey BV, NL) in two Hatchtech™ incubators. After five days of age, temperature of the setter was adjusted to maximize heat production of the egg mass. Temperature, humidity, and carbon dioxide measurements were recorded every fifteen minutes during the incubation period. Weight loss, fertility, stage of embryonic death, chick weight, and hatchability were recorded for each incubator. Test incubators were compared to control incubators that contained eggs from the same flocks. Results showed a two percent increase in hatchability (90.3 and 89.3 versus 88.2 and 86.8 percent) for the test incubators when compared to the control setters that resulted, primarily, from decreased late dead embryos. Heat production was found to be .20 and .19 watt/egg, respectively for trial I and II which was similar to previously reported for high yielding broilers. In summary, real time monitoring of incubation can result in gains in hatchability by controlling embryonic heat production during critical periods of incubation.

Key Words: Incubation, Embryonic Heat Production, Temperature

529 Reduction of turkey hatching egg shell contamination with ultraviolet irradiation. R. A. Russo*, C. Chavez, T. P. Niemeyer, P. L. Reynolds, and J. B. Carey, *Texas A&M University, College Station, TX.*

The germicidal effects of 254nm ultraviolet light (UV) have been well documented in other sanitation applications. Field trials were conducted to test the impact of UV exposure on turkey hatching egg shell microbial contamination. An egg washing unit (with a motorized finger-type conveyor belt) was modified to be utilized as a UV chamber. Nine 40 watt lamps (three on top and three on each side) were placed in the UV chamber. The lamps operated at an intensity of $\geq 10.84\text{mW/cm}^2$ and egg exposure time was 45 seconds. The conveyor belt allows for the eggs to pass through individually and rotate on the longitudinal axis as they pass through the chamber, allowing full exposure of the shell to the UV radiation. Five trials were conducted with eggs from commercial turkey breeder flocks. Sixteen eggs were used in each trial (8 controls, 8 treated). After treatment, eggs were placed in 50mL of sterile phosphate buffer solution (PBS) and massaged for 4 s. Serial dilutions of the PBS were plated in duplicate on plate count agar (PCA), eosin methylene blue agar (EMB) and brilliant green agar (BGA). All plates were incubated at 37C for 48h before enumeration. In all trials, PCA counts of treated eggs were significantly lower than those of controls. *Salmonella* colonies detected on EMB was significantly lower on treated eggs in 4 of the 5 trials, and not significantly different in the other 1. *E. coli*

colonies enumerated on EMB were significantly lower in 2 of the trials, and not significantly different in the other 3. *Salmonella* colonies enumerated on BGA were significantly lower on treated eggs in 2 trials, and not significantly different in the other 3. *E. coli* colonies detected on BGA were significantly lower in 2 of the trials, and not significantly different in the other 3. These data indicate a potential for reduction of egg shell microbial contamination of turkey hatching eggs with UV irradiation.

Key Words: UV irradiation, Turkey hatching eggs, Egg shell contamination

530 The effects of age at photostimulation on reproductive efficiency in three strains of broiler breeders varying in breast yield. N. S. Joseph*¹, F. E. Robinson¹, R. A. Renema¹, and M. J. Zuidhof², ¹*University of Alberta, Edmonton, AB, Canada,* ²*Alberta Agriculture, Food and Rural Development, Edmonton, AB, Canada.*

The effects of photostimulating at 20 versus 23 wk of age were examined in three strains of female broiler breeders (Arbor Acres Farms Inc.; Classic, Feather Sexable Yield [FSY], and an experimental line [EXP]). The EXP line had been selected for more breast muscle yield than the other two strains. One objective was to determine if genetic selection for meat yield has changed the age at onset of lay. A second objective was to examine varying ages at photostimulation. At 19 wk of age, 48 pullets from each strain were housed in individual laying cages. The photoperiod during rearing and at the time of placement was 8 h of light/d. A solid black curtain was placed down the center of the room, dividing it into two halves. At 20 wk of age, one-half of the birds were photostimulated by increasing the photoperiod to 15 h of light/d. The other half remained on 8 h of light/d until 23 wk of age when they received the same increase in photoperiod as the 20-wk treatment. Strain of bird had no effect on age at sexual maturity. Birds that were photostimulated at 23 wk of age weighed more and were older at sexual maturity than birds photostimulated at 20 wk of age (185.6 and 180.0 \pm 1.1 d of age, respectively). However, once photostimulated, the pullets in the 23-wk treatment took less time to reach peak production than those in the 20-wk treatment. The later-photostimulated group had a higher mean egg weight throughout lay. There was no strain or treatment difference in hen-day egg production or settable egg number. Breast weight was heavier for EXP than Classic and FSY hens at 53 wk of age. The later-photostimulated group had more large yellow follicles than the early-photostimulated group. Although there were strain differences in breast muscle weight, strain did not affect the number of eggs produced. Delaying photostimulation by 3 wk was effective as hens began production faster and had an increased egg weight throughout lay without a decrease in egg production.

Key Words: Broiler breeder, Photostimulation age, Reproductive parameters

531 The effect of administering Oasis™ hatching supplement prior to chick placement on growth and body weight uniformity of female broiler breeders. S. I. Boersma*, F. E. Robinson, G. M. Fasenko, and R. A. Renema, *University of Alberta, Edmonton, AB, Canada.*

Transportation of broiler breeder chicks may cause energy loss and dehydration during the time period between hatch and placement. Arbor Acre Classic broiler breeder pullets were used to examine the effects of chick hatch condition on flock BW uniformity. Chick hatch condition assessment included eggshell quality, moisture loss, chick weight at hatch and chick weight 36 h post-hatch. A total of 2500 broiler breeder parent eggs were incubated and 856 female broiler breeders were successfully pedigree hatched in order to match egg and chick weights. An equal number of chicks received one of two treatments as follows; Assisted (AST), received Oasis (Novus International Inc., St. Louis, MO) for 36 h; Control (CON), received no hatching supplement. Chicks were placed in 8 floor pens (107 birds/pen) in a light-tight facility from 36 h post-hatch to 18 wk of age. Individual BW were recorded at 1, 2, 3, 4, 8, 12, 16, and 18 wk of age. Feed allocation was determined according to group BW following breeder guidelines. Eggshell quality, egg set weight and chick hatch weight were similar between AST and CON treatment groups. The AST post-hatch weights were lower than CON (37.24 g compared to 37.86 g, P = 0.0058). However, BW for AST treatment were higher than CON for 1, 2, 3 and 4

wk, as well as the BW gains for 0-1, 2-3 and 16- 18 wk. The AST treatment showed more variation in BW uniformity at wk 1 (CV of 10.21%) than CON treatment (CV of 9.16%). Overall, AST and CON birds had similar BW uniformity throughout the rearing period. Whereas Oasis treatment did not affect pullet BW uniformity beyond 1 wk of age, it may contribute to enhanced BW and BW gains during the first 4 wk of the rearing period.

Key Words: Broiler breeders , Body weight uniformity, Chick quality

532 Physical traits and reproductive success in male primary broiler breeders. S. McGary*¹, I. Estevez¹, M. R. Bakst², and D. L. Pollock³, ¹Univ of MD, College Park, MD 20742, ²USDA-ARS, Beltsville, MD 20705, ³Perdue Inc, Salisbury, MD 21802.

Genetic selection for high yield in primary broiler breeder males may result in skeletal modifications that impede sperm transfer upon mating. In addition, fluctuating asymmetry (FA) in bilateral traits has been shown to reliably indicate male reproductive potential in some avian species. The goal of this study was to determine if physical variation due to genetic selection and FA could explain and predict differential fertility and semen quality in male broiler breeders. Sixty males from two primary broiler breeder strains (A and B) were individually housed with an average of 10 females. Fertility was estimated by examining the germinal disc (GD), and semen quality by counting sperm penetration (SP) through the perivitelline layer. At 50 wks, body weight (BW) was taken and males euthanized. Posterior pelvic length and width (PPL and PPW), dorsal pelvic length and width (DPL and DPW), tarsometatarsal length and width (TL and TW), and wattle length and width (WL and WW) were measured with digital calipers. Strain differences included BW ($P < 0.01$), WL ($P < 0.0001$), WW ($P < 0.0001$), PPL ($P < 0.01$) and DPW ($P < 0.001$). The degree of FA in TL ($P < 0.05$) and WL ($P < 0.05$) was greater in Strain A, however FA did not correlate with fertility or SP in either strain. Strain A WL correlated with SP ($r = 0.295$; $P < 0.05$). There was a negative relationship between Strain A fertility and DPW ($r = -0.298$; $P < 0.05$). Strain A DPW alteration may affect sperm transfer upon copulation, however, this correlation was weak and should be further investigated to validate the relationship between pelvic structure and copulatory success. Fertility and SP did not correlate with physical traits in Strain B. Strain differences demonstrate potential impact of selection on physical traits. A significant relationship between comb

size and Strain A fertility has been previously shown, and the present study provides further evidence supporting evaluation of sexual traits as fertility indicators for Strain A.

Key Words: Broiler breeder, Fertility, Genetic selection

533 Effects of rearing feed intake on carcass characteristics of male broiler Breeders to 26 wk of age. R. H. McGovern*¹, J. L. Wilson¹, F. E. Robinson², and L. F. Bouvier², ¹The University of Georgia, ²University of Alberta.

Male broiler breeders require adequate fleshing to attain sexual maturity, while at the same time must remain lean enough to prevent them from becoming too large to mate naturally during the breeding period. Knowledge of the skeletal and carcass characteristics of male broiler breeders has been proposed as a management technique. Four hundred and eighty commercial male broiler breeders were reared in 12 floor pens. Birds were assigned to one of four rearing feed level treatments: standard (SF) (recommended BW profile), plus 15% (P15) (BW approximately 15% heavier than the SF), plus 30% (P30), and full fed (FF) at 1 d of age. Starting at 21 wk of age, male BW was restricted to attain the recommended breeder BW at 24 wk of age. Shank length, keel length, chest width, head width, and comb height were recorded for all birds. Forty birds (10 birds per treatment) were dissected at 6, 12, 18, 20, 22, 23, 24, 25, and 26 wk of age. Shank color and a visual shank color score of all males were assessed from 12 wk of age. The FF treatment males had the greatest gain from 5 to 6 wk of age (334 g) and maintained the greatest BW at 18 and 20 wk of age (3395g and 3747g, respectively). At 6 wk, the FF and P30 treatment males had the greatest fatpad weight compared to the SF bird (17.3g and 18.2g, respectively compared to 7.5g). The FF males had a greater BW and greater breast muscle development than the other BW treatments at 12, 18, and 20 wk. There were no differences in testes weight among the treatments prior to photostimulation at 22 wk. Head width, comb height, chest width, keel length, and shank length were increased in early rearing with feeding level. From 22 to 24 weeks of age, the FF males are in a period of BW weight loss. Testes of birds in the FF treatment were smaller compared to the P30, P15, and SF treatment males at 24 wk (11.7 g, 26.6 g, 29.2 g, and 25.5 g respectively).

Key Words: Male broiler breeders, Carcass characteristics , Testes

PSA Immunology

534 Major histocompatibility (B) complex gene dose effects on Rous sarcoma virus tumor growth. T. A. Tupick¹ and R. L. Taylor, Jr.*¹, ¹Dept. of Animal and Nutritional Sciences, University of New Hampshire, Durham, NH 03824.

This study's objective was to examine major histocompatibility (B) complex (MHC) gene dosage effects on the outcome of Rous sarcomas. Matings between Line UNH 193 ($B^{19}B^{19}B^{19}$) trisomic sires and dams produced progeny having $B^{19}B^{19}$ (disomic), $B^{19}B^{19}B^{19}$ (trisomic) or $B^{19}B^{19}B^{19}B^{19}$ (tetrasomic) MHC chromosome doses. The MHC and the nucleolus organizer region (NOR) are both located on a medium size microchromosome, designated 16. Nucleoli from feather pulp cells were enumerated using phase-contrast microscopy to determine chromosome dose. Six-week-old chickens were inoculated in the wing-web with 30 pock forming units (pfu) of subgroup A Rous sarcoma virus (RSV). Tumors were scored for size six times over a 10-wk period. The six tumor size scores were used to assign a tumor profile index (TPI), which indicates the degree of tumor growth. The TPI values, based on the general regressive nature of the B^{19} haplotype in these chickens, were 1 = complete regression by 28 days, or earlier; 2 = complete regression by 42 or 56 days; 3 = complete regression by 70 days, or a decreasing slope, or complete regression by 56 days followed by recurrence; 4 = general upward trend, or plateau or slight regression after 56 days; 5 = terminal tumor prior to 70 days. Mean tumor size scores were evaluated by repeated measures analysis of variance. The TPI values were rank transformed and analyzed by ANOVA. Fisher's Protected LSD at $P < 0.05$ separated significant means. The 88 chickens that developed tumors were 28 disomic, 47 trisomic and 13 tetrasomic types. No difference in tumor growth over time was detected among the three MHC gene doses with most chickens regressing their tumors. Disomic chickens had a significantly lower TPI than trisomic but not tetrasomic chickens. The TPI of trisomic and tetrasomic chickens did not differ significantly.

These data indicated that MHC dose alterations, at least to the trisomic level, have a negative impact on Rous sarcomas tumor outcome.

Key Words: Oncogene, Tumor, Aneuploid

535 Wattle swelling and antibody titers in BSA hypersensitive and naive hens. Paul Cotter*¹ and Swami Halidi², ¹Framingham State College, ²Department of Animal and Poultry Sciences, University of Guelph, Canada.

Wattle swelling was measured at 4, 24, 48, and 72 h in hens challenged with BSA. The swelling responses in those hens previously sensitized to BSA were greater at measurements up to 48 h compared to naive hens. Extraordinary swelling was observed in 10, 6 and 3 of 13 sensitized hens and in none of the naive hens at 4, 24 and 48 h respectively. Thus 19 of 39 (49%) of the presensitized group responses were not considered salutary versus none in the naive group. There was a slight tendency for the sensitized hens to show weight loss at one wk after the challenge but some loss occurred in certain naive hens as well. The log₂ antibody titers to BSA were detected by passive hemagglutination. These were 2.8 in naive hens and 8.0 in the sensitized hens at the time of the wattle challenge. Titers rose to 8.0 in naive hens but fell slightly to 7.2 in sensitized hens one wk after the wattle challenge. Natural antibodies to mouse and rabbit erythrocytes were also affected by the wattle challenge. Anti-mouse titers rose from a prechallenge average log₂ of 1.9 to 3.4. Anti-rabbit titers also rose from 4.8 to 6.7 during the same period. The net change in both types of natural antibody was about the same (1.7) for the two groups. Overall it appears as if total antibody output is balanced so that increasing one type is offset by decreasing or not changing another type. Thus changes in humoral immune output (natural and acquired antibody levels) accompanied the

cell mediated wattle reaction. Based on the combined observations a theory called "immunologic homeostasis" is advanced. Accordingly net immunologic work does not change in a well-balanced system. Temporary immunologic needs are met by drawing from available reserves so that momentary perturbations in this system may be accommodated. Implications of this theory may extend to both infectious diseases and vaccination.

Key Words: wattle swelling, antibody, immunologic homeostasis

536 High-Throughput Gene Expression Profiling To Study Host-Parasite Interactions In Avian Coccidiosis. H Lillehoj^{*1}, W Min¹, J Zhu¹, C Ashwell², C Van Tassel³, T Sonstegard³, J Burnside⁴, and B Matthew⁵, ^{1,2,3}*U.S. Department of Agriculture-ARS, Beltsville, MD*, ⁵*U.S. Department of Agriculture-ARS, Beltsville, MD*, ⁴*University of Delaware, Newark, DE*.

Coccidiosis is an intestinal infection caused by intracellular protozoan parasites, *Eimeria*. Understanding the interaction between host and parasites is crucial in designing new approaches. Documented evidence that T cells are the primary effectors of immunity to *Eimeria* has led to further interest in understanding the role of T cells in coccidiosis. *Coccidia* induces local and systemic changes in many cytokines including IL-2, IL-15, IFN-gamma and TGF-beta4. To better characterize host-parasite interactions, high-throughput gene profiling DNA arrays were used to identify genes with altered expression following infection with *E. acervulina*. Over 1000 expressed sequence tag (EST) genes from an activated T cell library, including those for several cytokines, were arrayed on DNA chips and hybridized with mRNAs from *E. acervulina* infected intestinal cells. Over 200 genes showed significant changes following infection. The success of this DNA microarray approach prompted us to construct a normalized cDNA library from intestinal cells after infection *Eimeria* to identify specific genes regulating protective immunity. This library contains 1.87 times 10⁷ transformants/ml with an average insert size of 1.56 kb. Presently, single pass sequence was obtained on over 6000 EST clones of which 80% contain high quality inserts and 50% are unique based on a BLAST search. DNA microarray analysis of this library will allow better characterization of chicken genes involved in local host-parasite interactions in avian coccidiosis (Supported by Fund for Rural America, Grant No 9704985 and partially by ARS CRIS).

Key Words: DNA microarray, intestinal genes, coccidiosis

537 Seroepidemiology of Newcastle disease virus in wild pigeons in Shahre-Kord in Iran. Majid Bouzari^{*1} and Khodarahm Argang², ¹*Department of Biological Sciences, Faculty of Sciences, Isfahan University, Isfahan, Iran*, ²*Private Veterinary Practitioner, Shahre-Kord*.

Newcastle disease is one of the most important viral diseases of poultry in Iran. It is an enzootic disease and sometimes epizootic. It causes a great loss in poultry industry. Wild birds may act as reservoirs and play an important role in the spread of the virus among poultry flocks. Among wild birds pigeons which have easy access to poultry houses and food stores may play a critical role in the spread of the disease. For determining their role, 390 wild pigeons from three different areas in Shahre-Kord province (Shahre-Kord, Saman and Kiar) were captured and their blood serums were examined for the presence of antibodies against Newcastle disease virus by hemagglutination inhibition (HI) test in autumn and winter of 1998 and spring and summer of 1999. HI antibody titers of 1, 2 and 3 and above were categorized as negative, suspected and positive respectively. Chi-square test was used for statistical analysis. HI titers of up to 7 (log base 2) were recorded. The percentage of the negative, suspected and positive HI antibodies in the whole area were 32.88, 19.18 and 47.94 in autumn, 9.62, 17.30 and 73.08 in winter, 50.45, 18.02 and 31.53 in spring and 63.64, 13.64 and 22.73 in summer respectively. Significant differences were observed between winter and other seasons ($P < 0.05$). The differences between spring and summer, and spring and autumn were not significant ($P < 0.05$). No significant differences were observed among different areas ($P < 0.05$). The rate of contamination in wild pigeons in areas studied was 31.88-41.45 percent with 95% confidence interval. The higher level of positive birds in winter could be correlated to overcrowding of the pigeons in places which is called Ghanat and the higher possibility of feeding in food stores of poultry farms due to lack of enough seeds during this season. The lower rate of positive birds in spring could be correlated to the introduction of new young birds to the whole population and more availability of food in nature and as a results less crowding and less contact with poultry

farms. It was concluded that wild pigeons might act as reservoirs and play an important role in the spread of the Newcastle disease virus.

Key Words: Newcastle disease virus, Seroepidemiology, Wild pigeon

538 Comparison of PEMS-associated and classical astroviruses-mediated effects on performance and immune functions of turkey poults. M. A. Qureshi^{*1}, Y. M. Saif², R. A. Ali¹, F. W. Edens¹, C. L. Heggen-Peay¹, and G. B. Havenstein¹, ¹*NC State University, Raleigh, NC*, ²*The Ohio State University, Wooster, OH*.

Poult enteritis and mortality syndrome (PEMS) is an acute, infectious, transmissible intestinal disease of young turkeys. A turkey astrovirus (TAst-OSU) of 30-32 nm size was isolated from intestinal contents of poults exhibiting clinical signs of PEMS. While involvement of astroviruses in enteric disease is not new, they have achieved a renewed importance due to their involvement in PEMS. Experimental inoculation of turkey poults with purified TAst-OSU resulted in growth suppression, diarrhea, 100% morbidity with variable mortality, significant atrophy of thymus and bursa, and reduced lymphoblastogenesis. We have, therefore, compared the recent PEMS TAst-OSU isolate with the "Classic turkey astrovirus" (C-TAst) which was isolated and reported in 1986 (Avian Dis. 30:728). Specific-pathogen-free poults were housed in HEPA-filtered bubble-type isolation units and exposed to 10³EID₅₀ TAst-OSU or C-TAst in 1 mL/poult at 7 d of age. Control poults received 1 mL of sterile PBS. Poults in both virus-challenge groups exhibited reduced ($P = 0.01$) wt gain (123 - 129 g) as compared with the control (141 g) poults at 7 dpi. While bursal development was not affected, poults in both TAst-OSU and C-TAst groups had significant reduction in thymic growth ($P = 0.0006$) and enlarged spleen ($P = 0.044$) vs. control poults at 7 dpi. Lymphoblastogenic response stimulation index against concanavalin-A was lowest in TAst-OSU (0.304), as compared with the C-TAst (0.542) and control (1.182) poults ($P < 0.05$). Poults in C-TAst group exhibited over a 1 log reduction ($P = 0.044$) in total and IgM anti-SRBC antibodies whereas TAst-OSU poults exhibited antibody levels comparable to the control poults. Therefore, this study indicates that the PEMS-associated (TAst-OSU) and the classic turkey astroviruses (C-TAst) are capable of inducing performance and immune function defects. However, these two astroviruses appear to differ in their effects on immune endpoints in young turkey poults.

Key Words: PEMS, astroviruses, immune functions

539 PEMS-associated reovirus: viral replication, effects on avian cell livability, and cytokine expression. M. A. Qureshi^{*1}, C. L. Heggen-Peay¹, K. A. Schat², B. Sherry¹, M. A. Cheema¹, R. A. Ali¹, and P. H. O'Connell², ¹*NC State University, Raleigh, NC*, ²*Cornell University, Ithaca, NY*.

We have recently isolated a reovirus from intestinal contents of poults suffering from poult enteritis and mortality syndrome (PEMS). This PEMS-reovirus (CU-98) is approximately 80 nm in size and consists of 10 dsRNA segments clustered in three size classes, designated large, medium and small, based on electrophoretic mobility. Experimental challenge of poults with CU-98 resulted in decreased liver and bursal weights suggesting contributory role of reovirus in PEMS. In the current study we examined the interaction of CU-98 with LMH, a liver hepatocyte cell line; MQ-NCSU, a macrophage cell line; and RP-9 and DT-40 (B lymphocyte cell lines) by exposing the cells to 10-fold dilutions of the CU-98 stock. CU-98 produced CPEs (e.g., syncytia, rounding, sloughing) only in LMH cells with 10⁶TCID₅₀. CU-98 was found in abundance in cytoplasm of LMH cells via TEM. In contrast, CU-98 particles were detected bound to the MQ-NCSU cell surface but not within the cytoplasm. When CU-98 infected and noninfected LMH and MQ-NCSU cells were examined electrophoretically after metabolic labeling with ³⁵S-methionine, viral protein bands of 145 and 43 kD were found in infected LMH cell lysates but not in MQ-NCSU lysates. Single oral challenge of poults with CU-98 resulted in low-titer (1:4) neutralization antibodies at 10 dpi. CU-98 was plaque-purified and exposed to MQ-NCSU. IL-1 mRNA was examined at 2 h time points by RT-PCR. While no IL-1 mRNA was detected in sham-exposed macrophages, IL-1 was upregulated in macrophages after 2 h of virus exposure and seemed to decrease in a time-dependent manner up to 10 h of exposure. In contrast, IL-1 mRNA was present in both sham and virus exposed LMH cells and appeared to decrease after 8-10 h suggesting a possible down-regulation of IL-1 by CU-98 in liver cells and signaling the beginning of

CPE. These findings imply that PEMS-reovirus may be a key contributory agent in the overall PEMS etiology. Furthermore, some immunological and metabolic alterations observed in PEMS poultts may also be attributable to exposure to reovirus.

Key Words: PEMS-Reovirus, CPE, Cytokines

540 Non-covalent modification of protein antigens can direct them to scavenger receptors and induce inflammatory immune responses. S.S. Vandaveer*, G.F. Erf, and J.M. Durdik, *University of Arkansas.*

After pathogen invasion, an organism's survival depends on choices the immune system makes. For intracellular infections, the body can choose one of two pathways mediated by T helper type 1 (Th1) or 2 (Th2) cells. Th1 cells produce inflammation, and Th2 cells, antibody-production. Choosing Th1 over Th2 can prevent host mortality and promote recovery. One way to induce a Th1 response in chickens is to target antigens to scavenger receptors (SR), expressed on B cells and macrophages. Conjugating maleic anhydride to an antigen confers a negative charge to it, allowing it to effectively bind to SR. This binding can be specifically reduced by preincubation with other known SR ligands, evidenced by flow cytometry and immunohistochemistry. We have shown that Th1 responses can be induced by direct covalent modification of protein antigens with maleic anhydride as evidenced by functional biological tests (wattle swelling vs. antibody titers) and confirmed with molecular tests for interferon (IFN) γ production. Our hypothesis is that maleyl-pLL will serve as a general linker to deliver protein antigens to SR. We show that the protein need not be directly modified with maleyl to generate Th1 responses. Instead, we covalently modify poly-L-lysine (pLL) with maleyl and then take advantage of protein binding to pLL to deliver the pLL:maleyl-protein complex to SR. The advantage with pathogenic proteins is that linkers may be a benefit because of the practical difficulty in obtaining large amounts of protein antigen needed for direct chemical modification. The pLL was tested as a linker for a model protein antigen, bovine serum albumin (BSA). Chickens were injected with pLL:BSA and maleyl-pLL:BSA to test for Th1 responses. As a result, maleyl-pLL:BSA produced significant wattle swelling and IFN γ production, indicative of a Th1 response. This was in contrast to antibody titers produced against pLL:BSA immunization, indicative of a Th2 response. The data establish the likelihood that maleyl-pLL can be used as a linker to deliver many protein antigens to SR to induce Th1 responses in birds.

Key Words: Macrophages, T cell subsets, Scavenger receptors

541 Hypo and Hyper responsiveness to bacterial LPS may be due to differential expression of Toll-like receptor-4 in chicken macrophages from different genetic backgrounds. N. Dil* and M. A. Qureshi, *NC State University, Raleigh, NC.*

Macrophages respond to external stimuli by inducing the expression of various cytokines, adhesion molecules, and enzymes, that modulate various immune functions. Inducible nitric oxide synthase (iNOS) is one such enzyme that catalyses the biosynthesis of nitric oxide which in turn mediates several immunological and physiological functions. We have shown previously that macrophages from Cornell K-strain (B¹⁵B¹⁵) exhibit higher iNOS activity in terms of nitrite production as compared with GB1 (B¹³B¹³) and GB2 (B⁶B⁶) chicken macrophages regardless of the LPS bacterial source. In the current study we exposed macrophages (1 x 10⁶) to 5 μ g/mL LPS from *Escherichia coli*, *Shigella flexneri*, *Serratia marcescens*, and *Salmonella typhimurium*. Northern-blot analysis revealed that K-strain macrophages expressed higher intensity of iNOS mRNA (iNOS/ β -actin ratio) than macrophages from GB2 (which was hardly detectable even in 20 μ g total RNA) regardless of the LPS source. We further investigated if any differences exist in possible molecular mechanism(s) involved in iNOS gene expression in these two strains of chickens. The constitutive expression of LPS-related macrophage cell surface receptors CD14 and Toll-like receptor-4 (TLR4) was examined via flow cytometry using anti-human CD14 and TLR4 antibodies. CD14 surface expression and intensity was not different between macrophages from K and GB2 chickens. In contrast, while the overall percentage of TLR4-positive macrophages was the same (K-strain, trial 1 = 92%, trial 2 = 62%; GB2, trial 1 = 91%, trial 2=64%), the receptor intensity (i.e. receptor numbers) was significantly higher ($P=0.05$) in K-strain macrophages (mean fluorescence intensity trial 1 = 145; trial 2 = 131) than in GB2 (trial 1 = 101; trial 2 = 98) macrophages. Furthermore, TLR2 (a previously thought candidate as LPS signaling molecule)-positive cell numbers were higher in K-strain than the GB2 macrophages

in one of the two trials with no difference in the intensity of TLR2 cell surface expression in either trial. These findings suggest that the observed differences in iNOS expression and activity among the K-strain (hyper responder) and GB2 (hypo responder) chickens are, at least in part, due to differential expression of LPS signaling molecule, namely Toll-like receptor-4, leading to relatively stronger LPS-mediated activation of K-macrophages.

Key Words: iNOS, CD14/TLR4, macrophage

542 Effect of a *Lactobacillus*-based dietary probiotic on oocyst shedding and interferon- γ production following *Eimeria acervulina* infection in broilers. R. A. Dalloul*¹, H. S. Lillehoj², and J. A. Doerr¹, ¹Dept. of Animal & Avian Sciences, Univ. of Maryland, College Park, MD/USA, ²Parasite Biology, Epidemiology and Systematics Laboratory, USDA-ARS, Beltsville, MD/USA.

Previously we reported increased resistance (reduced fecal oocysts) in *Lactobacillus*-treated broilers to *Eimeria acervulina* (EA). The present study was designed to examine IFN- γ (interferon-gamma) and oocyst production under similar conditions. Day-old male broiler chicks were fed control (CON) or probiotic-supplemented (PRO)(Primalac[®]) diets. In Exp. 1 (24 chicks/diet) chicks were orally challenged with 10⁴ oocysts of EA on day 20. Sera and intestinal secretions were sampled at 3, 6, 9, and 12 days post-infection (d PI). In Exp. 2 (8 chicks/diet), the chickens were challenged with 2x10⁴ oocysts/bird and oocysts were enumerated at 10 d PI.

Intestinal IFN- γ in CON chicks was constant through the sampling period except at 6 d PI when a significant ($P < 0.05$) increase occurred. In contrast, PRO chicks had a significantly higher IFN- γ at 3 d PI, which then declined until 12 d PI. No differences in serum IFN- γ were observed. No significant differences in anti-coccidial antibodies were found. Fecal oocyst shedding was slightly but significantly lower for PRO than for CON chicks; however, the reduction in shedding was not as great as in a previous study when half the inoculum rate was used. These results suggest an immunoregulatory effect of PRO diets on the local immune system in poultry and provide a rationale for further study to investigate the beneficial effects of *Lactobacillus*-based probiotics in food animals.

Key Words: Mucosal immunity, *Lactobacillus*, *Eimeria acervulina*

543 Antigen-Induced Ion Secretion in the Chicken Intestine Following Oral or Intraperitoneal Immunization Against Bovine Serum Albumin (BSA). J.L. McReynolds*¹, A.P. McElroy², H.D. Danforth³, and D.J. Caldwell¹, ¹Texas A&M University, College Station, TX, ²Virginia Tech, Blacksburg, VA, ³USDA/ARS/LPSI/PBEL, Beltsville, MD.

Our laboratories are investigating epithelial ion secretion, as mediated by Type I hypersensitivity, as a determinant and potential component of functional immunity in the chicken intestine. The present study evaluated antigen-elicited changes in ion secretion following immunization of SCWL chicks against BSA by oral or intraperitoneal (IP) routes. Oral immunization consisted of administering a daily *per os* bolus of 1 ml of 25 mg BSA/ml to chicks between 10 and 16 days of age. IP immunization consisted of administering 1 ml injections of 10 μ g/ml BSA-10mg alum (AlK(SO₄)₂) to chicks on either 1,7, and 14 or 10 and 16 days of age. IP control groups received 1 ml injections of 10 mg alum only. Distal ileal segments from BSA-immunized or control chickens were evaluated for *in vitro* responsiveness to antigen in Ussing chambers on days 20-22 of age in three replicate experiments. Ileal segments from oral BSA-immunized chickens responded to antigen in a significantly ($P < .05$) greater degree than other experimental groups. This response, a change in transmural short circuit current (Δ Isc), occurred within 1 minute of antigen exposure and reached a maximum level (Δ Isc=40.54) within 3 minutes. Response of negative control tissues was significantly lower (Δ Isc=12.47). When tissues from chickens receiving IP BSA or alum on days 1,7, and 14 were compared, significant differences were not observed (Δ Isc=12.78 and Δ Isc=7.87, respectively). Similarly, when ileal segments from chickens receiving IP BSA or alum on days 10 and 16 were compared, significant differences were not observed (Δ Isc=32.3 and Δ Isc=10.03, respectively). The present data confirm and extend previous findings from our laboratories suggesting epithelial ion secretion is a component of mucosal immunity in chickens. Further, these data may have important implications for vaccinating poultry against enteric pathogens.

Key Words: mucosal immunity, intestinal anaphylaxis, chicken

544 Utilizing solanum glaucophyllum and phytase to improve phosphorus utilization in broilers. Y-H Cheng^{*1}, J.P. Goff², J.L. Sell³, S Gill⁴, E. Pawlak⁴, M. Elena⁴, and R.L. Horst², ¹Iowa State University/Biomedical Science, ²National Animal Disease Center, ³Iowa State University/Animal Science, ⁴CAE, Buenos Aires, Argentina.

Both 1,25-dihydroxyvitamin D3 and phytase are known to improve phosphorus utilization in broilers (Biehl and Baker, J Nutr 1997). Solanum glaucophyllum (Sg) is a plant containing high amounts of 1,25-dihydroxyvitamin D bound to a glycoside. It may be an economical source of 1,25-dihydroxyvitamin D for animal feeds. We examined the effect of Sg, with and without phytase, on phosphorus utilization in broilers fed corn-soybean meal diets. The basal diet was 0.6% Ca, 0.45% total P (0.15% available P) with adequate vitamin D3 (3000 IU/kg). The six treatments included basal diet, basal with 7.5 g Sg/kg, basal with 10 g Sg/kg, basal with 1200 FTU phytase/kg, basal with phytase (1200 FTU/kg) and Sg (7.5 g/kg), and "normal" diet (0.7% total phosphorus, 1% calcium). Each treatment was given to six pens of 8 chicks. When compared with the basal diet, addition of 7.5 g Sg/kg or phytase improved growth and bone mineralization. Increasing Sg to 10 g/kg diet did not significantly improve weight gain or bone density over the 7.5 g Sg/kg dose. Phytase and Sg supplementation increased plasma and bone Ca and P concentration similarly, however the greatest weight gain and tibia ash was observed in the phytase (1200 FTU/kg) group. Adding 7.5 g Sg to the phytase supplementation did not significantly improve P utilization over phytase alone.

Diet	Blood P	Bone ash	Bone density	Weight gain
	mg/dl	g/tibiae	g/cm ³	gw
Basal(B)	4.56a	1.022a	1.117a	984a
B+7.5gSg	6.89b	1.194c	1.132b	1045b
B+10gSg	7.02b	1.246c	1.128ab	1046b
B+phytase	7.06b	1.348d	1.136b	1136c
B+phytase+7.5gSg	7.46b	1.375d	1.137b	1124c
Normal	7.54b	1.488b	1.158c	1033a

Key Words: Solanum Glaucophyllum, Phytase, Phosphorus

545 Effect of wheat bran phytase subjected to different conditioning temperatures on phosphorus utilization by broiler chicks based on body weight and toe ash measurements. W. B. Cavalcanti^{*}, K. C. Behnke, R. S. Beyer, and M. Okot-Kotber, Kansas State University, Manhattan, KS.

Cereal grains and oilseed byproducts are among the major components of diets fed to poultry. Although phosphorus levels are high in these ingredients, most of it is presented in phytate form and thus, unavailable. Wheat bran is known for having high phytase enzyme activity. A study was conducted with the objective of evaluating the efficacy of wheat bran in improving utilization of phytate phosphorus by broiler chicks. Four diets with increasing calculated levels of available phosphorus (Pav) (0.35, 0.40, 0.45, 0.50%) were used as references. Four test diets were formulated to contain 0.35% Pav. Three diets had a 5% inclusion of wheat bran subjected to different treatments: unconditioned, conditioned at 60°C and 80°C. The fourth diet had no wheat bran, but a commercial source of phytase. All treatments were isocaloric, isonitrogenous and formulated to meet or exceed NRC recommendations. Diets in the mash form were used in a (0-3) weeks battery study. Regression equations were used to estimate levels of Pav in the test diets. Increasing levels of Pav in reference diets resulted in improved live weight gain (LWG) and percent toe ash (PTA) on a dry matter basis. When utilized in the unconditioned form, wheat bran provided similar results for LWG and PTA to those obtained with the commercial phytase diet. Although some additional phosphorus was estimated to be available in those diets, due to phytase activity, the levels of the mineral were still below those recommended by the NRC. Increasing conditioning temperature (60°C and 80°C) lowered LWG and PTA of birds fed those diets. The results lead to the conclusion that wheat bran can be utilized in low Pav diets for broilers without any negative effects in LWG and PTA measurements when compared with diets containing proper levels of phosphorus. It may also be suggested that wheat bran cannot be conditioned or pelleted without losing most of its enzyme activity.

Key Words: Wheat bran, Phytase, Broiler

546 Evaluation of the available phosphorus requirement & optimal phytase level of 21-42 day old male broilers. J. R. Timmons^{*1}, J. M. Harter-Dennis¹, and A. E. Sefton², ¹University of Maryland Eastern Shore, Princess Anne, MD, ²Alltech, Inc., Guelph, Ontario, Canada.

Two trials were conducted to determine the available phosphorus (AP) requirement of 21-42 day old male broilers fed a corn & soybean meal diet. Also, the optimal dose & the phosphorus-sparing effect (PSE) of added phytase (Allzyme[®], Alltech, Inc.) was evaluated. A RCB design was used in both trials. Weight gain (WG), feed efficiency (G/F), tibia breaking strength (TBS) & % tibia ash (TA) were used as dependent variables. Trial 1 was conducted to determine the AP requirement of 21-42 day old male broilers. Treatments included 5 levels of AP (0.15, 0.20, 0.25, 0.30, & 0.35%). WG results were 829.1^b, 910.7^{ab}, 886.4^{ab}, 949.1^{ab} & 1026.7^a, respectively. There was no effect (P>0.05) of treatments on G/F. TBS & TA values were 24.2^d, 33.3^c, 35.7^{bc}, 38.9^{ab}, 40.5^a kg, & 45.5^c, 47.9^b, 51.4^a, 53.5^a, 53.5^a% for diets containing 0.15, 0.20, 0.25, 0.30 & 0.35% AP, respectively. Using TA the AP requirement was determined to be 0.29%. Trial 2 was designed to confirm the AP requirement from trial 1 & determine the optimum phytase level & PSE of added phytase. Treatments included 4 levels of AP (0.15, 0.20, 0.25, & 0.30%) & 4 levels of phytase (2875, 5750, 8625, & 11500 PTU/kg). All phytase diets contained 0.15% AP. WG & G/F values were 925.8^b, 947.7^b, 1011.8^{ab}, 1198.1^a g, & 0.283^b, 0.338^{ab}, 0.322^{ab}, 0.421^a in birds fed 0.15, 0.20, 0.25, & 0.30% AP, respectively. There were no differences (P>0.05) in WG & G/F between any of the phytase treatments. Both TBS & TA increased as the level of AP or phytase increased in the diet. TBS results were 13.2^e, 18.2^{bc}, 20.2^b, 23.5^a, 14.7^{de}, 17.0^{cd}, 18.3^{bc}, & 18.0^{bc} kg (AP & phytase levels, respectively). Using TA the AP requirement was determined to be 0.22%. The phytase level that maximized TA was determined to be 6769 PTU/kg. Also, the PSE of added phytase was estimated to be 0.04%. These results suggest that the AP level recommended by NRC may be high for 21-42 day old broilers.

Key Words: Phytase, Available phosphorus, Allzyme[®]

547 Reduction in dietary phosphorus concentration does not change brush border phytase activity along the small intestinal axis in broiler chicks. E. M. Onyango^{*1}, E. K. Asem², and O. Adeola¹, ¹Department of Animal Sciences, ²Department of Basic Medical Sciences, Purdue University.

A study was conducted to determine if intestinal brush border phytase activity in chicks could be altered by decreasing the phosphorus (P) content in the diet. A deficiency in P could lead to upregulation of enzyme systems involved in the digestion of its compounds. Two groups, each of six 7-day-old male broiler chicks, were fed either a P-adequate diet or a low-P diet for 2 wk. The corn-soybean meal based diet contained 10.1 g Ca and 7.4 g total P or 10.6 g Ca and 3.4 g total P per kg for P-adequate or low-P diet, respectively. The low-P diet had no inorganic P added. The broiler chicks were killed on day 21, the small intestine was removed, cleaned and divided into the duodenum, jejunum and ileum. Mucosa was scrapped and used to prepare intestinal brush border vesicles by the magnesium chloride precipitation method. Phytase activity (nanomoles Pi/mg protein/min) in the vesicles was measured at pH 6.0 using sodium phytate as substrate. Released Pi was reacted with ammonium molybdate to form a blue complex and quantified spectrophotometrically at 620 nm. Phytase activity (Mean SEM) in chicks fed P-adequate diet was 36.695 8.163, 21.087 4.486 and 4.706 0.125 in the duodenum, jejunum and ileum, respectively. Activity in chicks fed low-P diet was 29.732 2.610, 18.821 3.672 and 8.781 0.613 in the duodenum, jejunum and ileum, respectively. There was no significant difference in phytase activity in the duodenum, jejunum and ileum of chicks fed P-adequate diet and those fed low-P diet. Phytase activity was highest in the duodenum followed by the jejunum and lowest in the ileum in chicks fed either diet. It is concluded that, at the level of P used, P content in the chick diet does not seem to affect brush border phytase activity. Regardless of dietary P concentration, there was a proximal to distal decrease in phytase activity along the small intestinal axis.

Key Words: Broiler chick, Phytase, Phosphorus, Brush border membrane vesicle

548 Power of two methods for the estimation of bone ash of broilers. L. E. Hall*, R. B. Shirley, R. I. Bakalli, S. E. Aggrey, G. M. Pesti, and H. M. Edwards, Jr., *University of Georgia*.

An experiment was conducted to compare two common methods of estimating bone ash from growing broiler chicks (A = autoclaving; B = boiling/extracting). Ross x Ross day-old-broiler chicks were fed a corn-soy, phosphorus deficient diet (22.7% CP; 1% Ca; 0.2219% AP), with either 0, 750, 1500, 3000, or 6000 units of phytase. Method A was compared to method B at 7, 14 and 21 days of age by sacrificing chicks from each treatment and removing one leg from each bird for analysis by each method. Using method A, bones were autoclaved, cleaned of flesh and cartilage ends, oven dried (105°C for 24 hr), weighed and ashed at 600°C overnight, allowed to cool, and weighed. Using method B, bones were boiled, cooled, cleaned of flesh (not cartilage), extracted for 24 h with ethanol and 24 h with anhydrous ether, dried, and weighed and ashed as above. At d-7, bone ash ranged from 33.5±0.59 to 46.1±0.14% for method A, and 25.8±0.58 to 38.2±0.24% for method B. At d-14, bone ash ranged from 39.6±0.06 to 49.0±0.9% for method A, and 33.3±0.7 to 42.60.3% for method B. At d-21, bone ash ranged from 39.6±0.6 to 49.0±0.9% for method A, and 33.3±0.7 to 42.6±0.3% for method B. To detect a 2% difference in bone ash for any two treatments at a 5 and 90% power, it would require a sample size (n) of 52 and 51 for methods A and B, respectively at d-7; an n of 63 and 44 for methods A and B, respectively at d-14; and an n of 114 and 40 for methods A and B, respectively at d-21. The variability in method A increased with age, while the reverse was observed using method B. In conclusion, both methods can be used to determine bone ash, however, more numbers are required for the autoclaving method compared to the boiling/extracting method, at the same power of estimation.

Key Words: Broiler chicks, Phytase, Bone ash

549 Effect of dietary iron overload on plasma total antioxidant capacity and hepatic lipid peroxides in chickens. Jennifer Cosgrove*, Deniz Maurice, and Stephen Lightsey, *Clemson University, Clemson, SC 29634*.

We previously reported that dietary iron overload increased ascorbic acid (AA) synthesis and hepatic lipid peroxides and decreased storage of AA. These experiments involved sacrificing the animal; thus, it was desirable to find a method to estimate hepatic iron concentration (HIC) and oxidative/antioxidant status without killing the animal. Therefore, this experiment examined a possible correlation between HIC and plasma total antioxidant capacity (PTAC). Plasma antioxidant capacity can be easily measured from fresh plasma. Forty-eight 1-day-old Ross x Arbor Acre were separated into 4 groups of 16 birds and placed on one of 4 diets. The diets were a corn-soy starter diet containing a basal concentration of 250 mg/kg Fe, supplemental iron was provided as ground FeSO₄·7H₂O. Diet analysis showed the control diet contained an average of 250 mg/kg Fe, and diets 2, 3 and 4 contained 1233, 5123, and 10633 mg/kg respectively. The birds were maintained on these diets for 4 weeks before blood, kidney, and liver were collected. Response variables measured included: PTAC, plasma and liver AA, AA synthesis, hepatic and renal Fe, Cu, & Zn, and hepatic lipid and protein oxidation. The mortality rate was 50% in the birds fed diets 3 and 4. Those that survived exhibited a 500% depression in body weight and 500% increase in HIC compared to treatment 1 & 2. As expected, there was a significant decrease in stored AA (p<0.001) and increase in hepatic lipid peroxide values (p<0.01) in the highly overloaded animals. Results of the measurement of PTAC showed a similar trend in that levels from treatments 3 & 4 were significantly higher than levels from treatments 1 & 2 (p<0.001). These results show that measuring PTAC by this method can be useful when there is severe iron overload. From the pattern of iron overload seen in these birds, we cannot say with certainty that PTAC is effective or ineffective in detecting smaller differences in HIC.

Key Words: Hepatic Iron, Plasma Antioxidant Capacity, Ascorbic Acid Metabolism

550 Cloning and sequence analysis of manganese-containing superoxide dismutase(MnSOD) cDNA in chickens. X. G. Luo*¹, Y. Q. Bu¹, S. F. Li¹, C. Lu², Y. W. Li², T. D. Crenshaw³, X. Kuang¹, B. Liu¹, J. F. Li¹, and S. X. Yu¹, ¹*Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, P. R. China*, ²*Southwest Agricultural University, Chongqing, P. R. China*, ³*University of Wisconsin, Madison, U. S. A.*

The objective of this study was to identify the entire nucleotide sequence of MnSOD cDNA in chickens. Manganese is of particular importance for chickens. Previous studies by our laboratory demonstrate that MnSOD activity was significantly higher in heart than liver and other tissues for both broilers and laying hens. Only heart MnSOD was affected by dietary Mn levels in practical corn-soybean meal basal diets. The entire sequence of MnSOD cDNA in these chickens has not been cloned and defined. The sequence would aid future investigations of heart MnSOD gene expression as affected by dietary Mn. Therefore, in this study, a 990bp cDNA fragment encoding MnSOD from broiler chicken heart was amplified by 3'RACE (Rapid Amplification of cDNA Ends) with degenerate primers designed on the N-terminal amino acid sequence of chicken MnSOD. The amplified fragment was cloned and sequenced. The 5'terminal region of the MnSOD transcript was also determined by using 5'RACE procedure. The 5'RACE fragment is 521bp in length, including 352bp of the overlapped region with the 3'RACE fragment. The MnSOD cDNA in chicken heart is 1108bp in length, including 25bp of the 5'untranslated region, 675bp of the coding region, and 408bp of the 3'untranslated region. The coding region encodes a peptide of 224 amino acid residues, in which there is a signal peptide of 26 amino acids and a mature peptide of 198 amino acids. The molecular weight of the mature MnSOD protein is 22KD. Comparisons of the deduced amino acid sequence with those of human, rat, *C. elegans*, and *D. melanogaster* show the amino acid homology of 82.4%, 84.7%, 62.4%, and 59.3%, respectively. Supported by the National Foundation (Premier Foundation) of Outstanding Young Scientists of China in NSFC (Project No: 39925028).

Key Words: Cloning and sequence analysis, MnSOD cDNA, Chickens

551 Comparative bioefficacy of Natuphos phytase versus peniophora lysii phytase. M.B. Coelho, B.W. Cousins*, J Braun, and W.F. McKnight, *BASF Corporation, New Jersey*.

Two hundred fifty two day old broilers were utilized in a 3X3 factorial design (10 replications/treatment) to determine the bioefficacy of Natuphos[®] phytase compared with peniophora lysii phytase using a monocalcium phosphate standard. A phosphorus deficient corn/soybean diet was used as the control. This phosphorus deficient diet was supplemented with monocalcium phosphate (0.2, 0.4 and 0.6 g P/kg) or phytase (100, 200 and 300 U/kg). Bioefficacy was compared based on weight gain regression analysis. Regression equations of phytase effect on weight gain were $y=0.3247x + 761$, $R^2=0.8122$ and $y=0.147x + 761$, $R^2=0.0658$ for Natuphos and peniophora lysii phytase, respectively. Weight gain increased by 0.325 and 0.147 g per phytase unit for Natuphos and peniophora lysii phytase. Natuphos required fewer (p<.05) phytase units than peniophora lysii to reach 902 g bw (434 and 959 U, respectively). The bioefficacy of Natuphos and peniophora lysii phytase based on weight gain regression analysis were 100% and 45%, respectively.

Key Words: Phytase, Bioefficacy, Broilers

552 Phosphorus sparing effect of phytase, 25-hydroxycholecalciferol, and citric acid when fed to broiler chicks. R. Angel*¹, A. S. Dhandu¹, T. J. Applegate², and M. Christman¹, ¹*University of Maryland*, ²*Purdue University*.

An experiment was done to determine the non-phytate phosphorus (nPP) sparing effect of three feed additives (phytase (PHY), 25-hydroxycholecalciferol (25OHD3) and citric acid (CA)). Day-old, male Ross 308 chicks were placed in floor pens and fed a starter diet that met all NRC (1994) recommendations until 14 d of age. On d 14, 120 battery pens (eight birds per pen, eight pens per treatment) were assigned to fifteen treatments. The experiment was designed as a complete factorial arrangement of three PHY (0, 200 and 500 FTU/kg), two 25OHD3 (0 and 70 µg/kg) and two CA (0 and 3%) levels added to a low nPP (0.16%) and 0.80% calcium diet. Three additional diets that contained graded levels of nPP (0.24, 0.32 and 0.40%) were used to determine

a regression curve against which improvements in P utilization, based on tibia ash, were measured. Performance measures were determined from 14 to 24 d of age. All birds were sampled at 24 d and the right tibia removed for dry-defatted ash determination. Body weight gain was not affected ($P>0.05$) by any of the feed additives but feed consumption was lower ($P<0.05$) when CA was added. Feed-to-gain was positively affected ($P<0.05$) by the addition of PHY and CA. There was a main effect ($P<0.05$) of PHY, 25OHD3 and CA on tibia ash. No interactions were seen on any of the variables measured. When tibia ash was regressed on diet nPP a linear regression was obtained ($35.01 + 41.19 \cdot \text{nPP}$, $r^2=0.83$, $P<0.05$). Using this equation for tibia ash, the nPP sparing effect for the different feed additives was calculated. All three feed additives had a positive impact ($P<0.05$) on sparing effect but no interactions were seen. The sparing effects of the feed additives alone were 0.014, 0.048, 0.035 and 0.030% nPP when 200, 500 FTU PHY/kg, 3% CA, 70 μg 25OHD3/kg, respectively were added to the diet. The sparing effect when the highest levels of all three feed additives were used together was 0.116% nPP.

Key Words: Broilers, Citric acid, Phytase, 25-hydroxycholecalciferol, Non-phytate phosphorus

553 Non-phytate phosphorus sparing effect of phytase and citric acid when fed to poults. R. Angel^{*1}, T. J. Applegate², M. Christman¹, and A. S. Dhandu¹, ¹University of Maryland, College Park, ²Purdue University.

An experiment was done to determine the non-phytate phosphorus (nPP) sparing effect due to phytase (PHY) and citric acid (CA). Day-old, male Nicholas poults were placed in floor pens and fed a starter diet that met all NRC (1994) recommendations until 8 d of age. On d 8, 120 battery pens (nine birds per pen, eight pens per treatment) were assigned to fifteen treatments. The experiment was designed as a complete factorial arrangement of three PHY (0, 300 and 600 FTU/kg) and four CA (0, 1, 2 and 3%) levels added to a low nPP (0.44%) diet containing 1.20% calcium. Three additional diets were added that contained graded levels of nPP (0.53, 0.59, and 0.74%) and were used to determine a regression curve against which improvements in phosphorus utilization, based on tibia and/or toe ash, were measured. Performance measures were determined from 8 to 15 d of age. All birds were sampled at 16 d and the middle toe from both feet and the right tibia removed for dry-defatted ash determination. PHY and CA affected ($P<0.05$) gain, feed consumption, feed-to-gain ratio, toe and tibia ash but no interactions were seen. When tibia and toe ash were regressed on diet nPP, linear regressions were obtained ($29.11 + 44.28 \cdot \text{nPP}$, $r^2=0.90$, $P<0.05$; $0.45 + 34.38 \cdot \text{nPP}$, $r^2=0.88$, $P<0.05$; respectively). Using these equations the sparing effect of nPP for the two feed additives was calculated. A main effect ($P<0.05$) of PHY and CA on nPP sparing effect was observed but no interactions were seen. The sparing effect, based on tibia ash, was 0.0280 and 0.0898% nPP for 300 and 600 FTU PHY/kg, respectively. CA had an effect ($P<0.05$) only when added to the diet at a 3% (0.031% nPP) level. A similar sparing effect was found for 3% CA and for 600 PHY when toe ash was used (0.031 and 0.0875% nPP, respectively). When 600 FTU PHY/kg and 3% CA were used together the sparing effect was 0.130 and 0.125% nPP for tibia and toe ash, respectively.

Key Words: Broilers, Citric acid, Phytase, Non-phytate phosphorus

554 The effects of supplemental phytase on egg shell quality in broiler breeder hens. M. Lilburn* and J. Nixon, *The Ohio State University/OARDC.*

Environmental concerns coupled with legislative efforts aimed at minimizing nutrient excesses in animal manures have resulted in an array of dietary strategies to help achieve these goals. The enzyme phytase and its incorporation into commercial type diets has become one of these aforementioned tools. Phytase liberates phytate-bound phosphorus from plant source feedstuffs, ultimately resulting in greater dietary utilization of plant phosphorus and lower levels in the excreta. While there has been considerable literature on the phosphorus requirement of various classes of poultry and the role that phytase plays in meeting these requirements, there is still considerable confusion with respect to optimizing phosphorus nutrition and minimizing excretion. There has been considerable phytase research with commercial egg-type hens, but to date there is a paucity of research with broiler breeder hens. The objectives of the research reported herein was to study, in broiler breeder hens, the effects of different levels of available phosphorus (.12%, .22%, .32%)

in diets with and without supplemental phytase (0,300 units). Mature broiler breeder hens were fed these diets (154 g/hen/d) beginning at 36 wk of age and the experimental periods were 36 to 40, 40 to 44, and 44 to 48 wk. Egg production was recorded daily. During the last wk of each production period, all eggs were individually weighed and broken out for shell wt determination. There was an increase in egg wt with age and an increase in shell wt with age and level of available P. The best results were observed with 0.22% AvP. At the end of the study, all eggs were divided into 5 classes with mean egg wts of 54.5 g, 58.9 g, 63.7 g, 67.8 g, and 72.6 g. Within each egg wt class, the 0.22% AvP treatment resulted in the highest shell wt and this would have allowed for 334 mg AvP per day. The effects of supplemental phytase were inconsistent.

Key Words: Phytase, Phosphorus, Broiler breeder

555 Effect of dietary calcium and phosphorus levels on response of broiler chicks to phytase supplementation. F. Yan, J. H. Kersey, C. A. Fritts, and P. W. Waldroup*, *University of Arkansas.*

It has been frequently demonstrated that addition of phytase to corn-soybean meal diets will improve the utilization of the phytate-bound P for broiler chickens. The effect of the phytase on release of other nutrients is less clear-cut. One phytase producer suggests that Ca is also released by phytase and that consequently the dietary Ca level might be reduced. A study was conducted to examine the effects of phytase supplementation on diets with varying levels of Ca with different levels of nonphytate P. A diet was formulated that provided nutrients in excess of NRC (1994) with 1.0% Ca and 0.5% nonphytate P. By varying the amounts of dicalcium phosphate and limestone in aliquots of a common basal diet, diets were prepared with 1) Low-P and Low-Ca; 2) Low-P and High-Ca; 3) High-P and Low-Ca; 4) High-P and High-Ca. The diets were analyzed to determine Ca and P content and blended as needed to provide test diets in a factorial arrangement of three Ca levels (0.5%, 0.7%, 0.9%) with eight levels of nonphytate P (0.15% to 0.5% in increments of 0.05%). These 24 diets were then divided and half supplemented with 1000 units/kg of phytase (Natuphos#, BASF). Each treatment was fed to six pens of six male broilers from one to 21 d of age. When diets received no phytase, both BW and tibia ash (TA) were depressed at the lowest level of P as Ca increased. Adding phytase to these diets improved both BW and TA, as a result of increased availability of P. At both 0.5% and 0.7% Ca, the dietary Ca level was a limiting factor in maximizing both BW and TA regardless of level of nonphytate P or phytase supplementation. Diets containing 0.9% Ca supported greater BW and TA than diets with lower Ca levels regardless of P level or phytase supplementation. These data indicate that minimal Ca appears to be released by phytase and that no reduction in Ca should be implemented when diets are supplemented with phytase.

Key Words: Phytase, Calcium release, Phosphorus

556 Evaluation of dietary chlorine for turkey poults. K.D. Roberson^{*1}, ¹Michigan State University.

Dietary salt level has been linked to roundheart disease in turkey poults with dispute. Past research has focused on either added salt or specifically on sodium due to hypertensive effects associated with high dietary sodium. Problems with roundheart mortality have been common after 6 days of age in the turkey growout facility at Michigan State University when crumbles are fed. No roundheart mortality was observed in one trial when part of the sodium requirement was provided by sodium bicarbonate in place of sodium chloride in mash feed. A 14-day trial was conducted in a battery brooder to determine the effects of varying dietary chlorine levels on growth performance and roundheart mortality when dietary sodium was held constant at 0.17%. A corn-soybean meal-fish meal based diet was fed in a mash form to 6 pens of 8 toms per treatment. The calculated dietary chlorine levels were 0.17, 0.21, 0.25 or 0.29%. There was a quadratic ($p=0.010$) response of 14-d body weight to dietary chlorine as poults were lighter when 0.17% chlorine was fed (347 g) compared to poults fed 0.21 or 0.25% chlorine (370 or 374 g, respectively). There was no effect on feed efficiency. Mortality was low in the trial and not due to roundheart. Heart weight, as a percentage of body weight, ranged from 2.92 to 3.25% as dietary chlorine increased and resulted in a linear response at $p=0.080$. The results of this study suggest that altering the dietary electrolyte balance by feeding chlorine as high as 0.29% does not induce roundheart mortality in turkey poults.

The NRC requirement for chlorine (0.15%) appears to be too low for 0 to 4-week-old poult.

Key Words: Chlorine, Poult, Roundheart

557 Influence of supplemental citric acid and sodium and potassium citrate on phytate-phosphorus utilization in broiler chicks fed phosphorus-deficient diets from one to 42 days of age. Ahmed Metwally*, *Animal Prod. Dept., Fac. of Agric., Assiut University, Assiut-Egypt.*

Experiments were conducted to determine if the addition of citric acid to a phosphorus (P) deficient corn-soybean meal (SBM) diet would enhance phytate P utilization in broilers. Citric acid (C), Citric acid and

Sodium citrate(1:1 mixture,CS) and Citric acid and Sodium citrate and Potassium citrate (1:1:1 mixture, CSP) were added at levels of 0, 4.5 and 6% to a P-deficient diet containing 0.91 Ca and 0.22% available phosphorus. Each of three dietary treatments was fed to replicate groups of eight chicks from one to 42 days of age. Increasing levels of dietary citrate to 4.5% increases performance traits. Carcass quality and tibia weight and ash improved for chicks fed 4.5% mixture of CSP. The bone ash response to the mixture of CSP was much greater than the bone ash response to the mixture of CS. The results of this study indicate that the mixture of CSP at level of 4.5% enhances phytate P utilization in broiler diets from one to 42 days of age.

Key Words: Citrate, Performance, Phytate-phosphorus utilization, chicks

PSA Pathology Session I

558 Influence of IBDV on the immune system and incidence of proventriculitis in SPF leghorns. T.V. Dormitorio*¹, J.J. Giambrone¹, and K. Cookson², ¹*Auburn University, Auburn, Alabama*, ²*Ft. Dodge Animal Health, Lawrenceville, Georgia.*

Infectious bursal disease virus (IBDV) isolates have been linked to cases of proventriculitis in commercial broilers. These isolates appear to be variant in nature as they do not cause much edema, but mostly atrophy of the bursae. Some are very pathogenic and associated with immune suppressed flocks.

Fourteen-day old Specific Pathogen Free (SPF) white leghorns received four different IBDV vaccines. At 28 days, chicks were challenged with 707B IBDV isolate by eye and nose routes. At 34 days of age, pullets were tested for cell-mediated immune (CMI) response using a skin test. At 36 days of age all birds were killed and weighed, and the bursa were weighed and examined post mortem for gross lesions. Bursa weight to body weight ratios were also determined and the means of all groups analyzed for differences using SAS system.

SPF white leghorns were susceptible to the 707B IBDV field isolate at 26 days of age. Nearly 100% of these birds had severe gross lesions in bursa (atrophy) and proventriculus (glandular enlargement and edema), and numerically reduced final body weight. All commercial live intermediate IBDV vaccines produced excellent protection against proventricular lesions induced by this isolate. This IBDV isolate also cause a reduced CMI response. These data provide more evidence that this IBDV isolate had a major role in causing immunosuppression and proventriculitis in chickens.

Key Words: IBDV, Proventriculitis, CMI

559 In ovo administration of experimental reovirus vaccines^b. Z.Y. Guo* and J.J. Giambrone, *Auburn University, Auburn AL*.

Avian reoviruses are an important cause of poultry diseases worldwide and can induce various diseases in chickens. *In ovo* administration of viral vaccines is a new technique used in preventing diseases. It is commonly used for the administration of Marek's Disease and infectious bursal disease viruses (IBDV) vaccines in commercial broilers. According to our preliminary experiments, the current reovirus vaccine, Enterovax, complexed (combined) with specific antibody against reovirus was too pathogenic for *in ovo* use. Therefore, a milder reovirus vaccine, Chick Syno-vac, was employed. This vaccine, complexed with antibody, was able to induce immunity against reovirus challenge and was less pathogenic than Enterovax. We are currently examining an even milder vaccine (VA Chick Vac) combined with antibody to determine its pathogenicity and immunogenicity, when given by *in ovo* route.

Key Words: Reovirus, *In ovo*, Vaccination

560 Changes in serum levels of ovotransferrin during experimental inflammation and diseases in chickens. H. Xie*^{1,2}, N. Rath¹, F. Clark², L. Newberry², W. Huff¹, G. Huff¹, and J. Balog¹, ¹*PPPSRU, ARS, USDA*, ²*Department of Poultry Science, University of Arkansas.*

We have identified serum ovotransferrin as an avian acute phase protein. To measure the changes in serum levels of ovotransferrin during inflammation and poultry diseases, we developed a solid phase competitive

enzyme immunoassay using rabbit anti-chicken serum transferrin antibody and biotinylated ovotransferrin. Serum ovotransferrin competes with biotinylated ovotransferrin to bind to anti-chicken transferrin antibody. The residual biotinylated ovotransferrin bound to anti-chicken transferrin is then detected using streptavidin-horse radish peroxidase followed by a colorimetric detection step. Serum levels of ovotransferrin are then determined according to a standard curve generated using known concentrations of ovotransferrin. Inflammation was experimentally induced in 4-wk-old male broiler chickens by subcutaneous injection of croton oil, and specific pathogen free (SPF) chickens were challenged with various bacteria or viruses to induce specific disease. In the experimental inflammation model with croton oil, the serum levels of ovotransferrin increased by 16 h post-injection, reached a peak by 72 h, remained high through 5 days, and returned to the basal level of olive oil-injected sham-controls by 10 days. Similarly, compared to the control birds, SPF chickens challenged with *E.coli*, pox virus, reovirus, infectious bursal disease virus, or laryngotracheitis virus had significantly higher levels of ovotransferrin in serum ($P<0.05$). Our results demonstrate that ovotransferrin can be utilized as a clinical marker for inflammation associated with certain infectious avian diseases.

Key Words: Ovotransferrin, Inflammation, Enzyme immunoassay

561 Differential intestinal response to *Eimeria acervulina* challenge in broiler chickens. B.C. Morris*¹, H.D. Danforth², D.J. Caldwell³, and A.P. McElroy¹, ¹*Virginia Tech, Blacksburg, VA*, ²*USDA/ARS/LPSI/PBEL, Beltsville, MD*, ³*Texas A&M University, College Station, TX.*

Immunovariability between coccidial species in vaccines and those found in poultry rearing facilities has emerged as a potential complication associated with vaccination. The host pathogen interaction and immune response in the intestine must be further investigated to understand immunity and pathophysiology to *Eimeria* in chickens. Experiments were conducted comparing two isolates of *Eimeria acervulina* (EA), EA1 and EA2. In three experiments, commercial broilers chicks were divided into control (non-challenged) and EA1 or EA2 challenged (14 days of age) groups. In all 3 experiments, EA1 resulted in significantly ($P<0.05$) higher lesion scores than EA2, however, weight gain of EA1 challenged birds was not significantly different from controls. EA2 challenged birds had significantly higher lesion scores than control birds in Expts 1 and 3, with no lesions characteristic of classical EA infection in Expt 2. EA2 resulted in significantly decreased weight gain as compared to EA1 or control in Expt 3. While EA1 resulted in classical EA lesions with no significant difference in weight gain, EA2 resulted in few classical lesions with significant depression of weight gain. Subjective observation of intestines from EA2 challenged birds was suggestive of a severe secretory intestinal response and weakened intestinal strength. In Expt 4, EA2 oocysts were cleaned with 5.25% sodium hypochlorite to evaluate the possibility of an external bacterial factor contributing to the observed detrimental affects in the presence of few lesions. Birds were challenged with bleached or non-bleached EA2. Although there was no significant difference in lesion scores between EA2 challenged groups, non-bleached EA2 resulted in significantly decreased weight gain

as compared to bleached. These data are indicative of immunovariability between different isolates of the same coccidial species and are suggestive of differences in the host response that may contribute to the pathogenicity.

Key Words: *Eimeria*, Immunovariability, Broilers

562 Digestive and Reproductive Organ Characteristics in Commercial Laying Hens as affected by F-Strain *Mycoplasma gallisepticum*. M. R. Burnham^{*2}, S. L. Branton¹, E. D. Peebles², M. S. Jones², B. D. Lott¹, J. B. Yeatman², S. K. Whitmarsh², and P. D. Gerard³, ¹USDA, ARS, South Central Poultry Research Laboratory, ²Department of Poultry Science, Mississippi State University, Mississippi State, MS 39762, ³Agricultural Information Science, Mississippi State University, Mississippi State, MS 39762.

The effects of F-strain *Mycoplasma gallisepticum* (FMG) on digestive and reproductive organ characteristics in commercial laying hens were investigated. Ten hens were assigned to each of sixteen negative pressure fiberglass biological isolation units. Birds in eight units served as uninoculated controls and those in eight other units were inoculated (treated) with FMG at 12 wk of age. At 20, 36, 44, 46, and 48 wk of age, two birds from each of two units and at 60 wk of age, four birds from each of six units designated as either control or treated were euthanized by cervical dislocation and their organs removed. Variables examined included liver, duodenum, jejunum, ileum, infundibulum, magnum, isthmus, uterus, vagina, and ovarian weights, percentage liver moisture and lipid contents, and ovarian follicular hierarchical numbers. Organ weights were expressed as percentages of bird weight. Main effects due to bird age were observed for all parameters. Hierarchical follicle number decreased in FMG-treated hens relative to controls. Relative vagina weight was decreased at 20, 36, 44, and 48 wk by FMG; whereas, the effects of FMG on percentage liver moisture and lipid contents were inconsistent throughout the 20 to 60 wk period. These data suggest that changes in egg production in response to FMG infection in commercial layers, as noted in previous reports, may be associated with changes in liver and reproductive organ characteristics in commercial layer hens.

Key Words: *Mycoplasma gallisepticum*, necropsy, liver, intestine, ovary, oviduct, layer hen

563 Virulence Response of a *Salmonella* Typhimurium *hilA:lacZY* Fusion Strain to Spent Media From a *Salmonella* Typhimurium Poultry Isolate and Non-*Salmonella* Bacteria. J. D. Nutt^{*1}, L. F. Kubena², D. J. Nisbet², and S. C. Ricke¹, ¹Texas A&M University, College Station, TX USA, ²USDA-ARS Food and Feed Safety Research Unit, College Station, TX USA.

Salmonella invasion into host epithelial cells requires genes located on *Salmonella* pathogenicity island 1 (SPI). *HilA*, a transcriptional activator encoded on SPI1, is necessary for maximum expression of SPI1 genes and invasion into epithelial cells. Certain environmental factors stimulate the expression of SPI1 genes, specifically *hilA*, which can be used as an indicator of overall level virulence expression. Influential factors may include changes in the gastrointestinal environment of birds during different dietary regimes. The objective of this study was to determine if growth of specific microorganisms alters the environmental conditions sufficiently to signal *S. Typhimurium* virulence response. Spent media was obtained from a *hilA:lacZY S. Typhimurium* strain, a poultry *S. Typhimurium* strain and *Escherichia coli* K12 after 2 and 23 hrs incubation in brain heart infusion broth (BHI). Cells were removed by centrifugation and the supernatant was filter sterilized. Spent media samples (1.5ml) were each inoculated with 0.120ml of a *hilA:lacZY* fusion strain of *S. Typhimurium* inoculum and incubated for two hours. After incubation, β -galactosidase assays were performed on the samples to determine virulence expression. Although no significant differences were seen among the virulence responses of the three separate bacteria strains, in general responses were 5 to 10-fold higher ($p < 0.05$) than uninoculated BHI controls (40 to 50 Miller units) and more than doubled when exposed to 23 h spent media versus 2 h spent media for *S. Typhimurium* (481 to 507 versus 217 to 221 average Miller units). Based on these results, it appears that growth of similar bacterial species may alter the composition of rich media sufficiently to influence virulence.

Key Words: *Salmonella*, spent media, virulence

564 Viral disinfectant efficacy assay for duck hepatitis B virus using PCR. Chi-Young Wang^{*1} and Joseph Giambrone¹, ¹Auburn University.

The risk of transmission of human hepatitis B virus (HBV) by plasma concentrates has been reduced by use of virus inactivation procedures. However, serious concern persists over nosocomial infections that could be acquired through the use of inadequately disinfected equipment or accidental exposure to blood or other infectious body fluids from HBV-positive individuals. Duck hepatitis B virus (DHBV) is closely related to HBV and shares its general biological and structural properties. With the duck embryonic hepatocyte culture system and PCR, the evaluation of efficacy of disinfectants for DHBV was made more plausible and accurate. Nested PCR was also developed and could increase the limits of detection one hundred fold. In our study, when the concentrations of disinfectants (Quat-stat) were below 600ppm, they caused only a one log₁₀ reduction in titer (titer = 5×10^4 to 3.5×10^5 TCID₅₀/ml). If we increased the concentrations above 2400 ppm, it caused a reduction in titer ≥ 4 log₁₀. No cytotoxicity due to the disinfectants was observed on uninfected indicator cells. The U.S. EPA requires that a specific virucidal claim for a disinfectant intended for use on hard surfaces be supported by efficacy test. According to this, the optimal concentration of a compound is virucidal reduces the viral titer by 3 logarithm units. Therefore, the optimal concentration of "Quat-Stat" for DHBV was 2400ppm.

Key Words: Duck hepatitis B virus, nested polymerase chain reaction (nested PCR), viral disinfectant efficacy assay

565 Water-soluble tylosin tartrate (Tylan Soluble Powder) for treatment of necrotic enteritis in broiler chickens. J.J. Brennan^{*1}, R.B. Bagg², G. Vessie², J. Wilson³, D.A. Barnum³, G. Moore⁴, A. Zimmermann⁴, P. Dick², and S. Poe⁴, ¹Shur-Gain Agresearch, RR#3, Burford, ON N0E 1A0, ²Elanco Animal Health, Eli Lilly Canada Inc., Research Park Centre, 150 Research Lane, Guelph, ON N1G, ³Ontario Veterinary College, University of Guelph, Guelph, ON N1G 2W1, ⁴Elanco Animal Health, 2001 West Main Street, POB 708, Greenfield, Indiana 46140.

The effects of tylosin tartrate (Tylan[®] Soluble Powder) on mortality, intestinal lesion scores and growth performance of *Clostridium perfringens*-challenged broiler chickens were evaluated in a floor pen study. A randomized complete block design was used to study the effects of administration of 0, 50, 100 or 150 ppm tylosin tartrate in drinking water following confirmation of a necrotic enteritis (NE) outbreak. Each floor pen contained 25 male and 25 female birds on day of placement (Day 0). The pen was considered the experimental unit. There were ten replicate location blocks in the study. Challenge was administered via feed on days 14 and 15. An NE outbreak was confirmed based on NE mortality on Day 16. Medicated drinking water was introduced on Day 16 and provided for five consecutive days. On Day 17, three birds per pen were randomly selected, sacrificed and scored for necrotic enteritis lesions on a scale of 0 (normal) to 4 (extensive necrosis). Necrotic enteritis (NE) mortality (%) for the four respective treatments was 2.4a, 1.6ab, 1.4ab and 0.4b ($P < 0.05$) during Day 16 to 28. Mean small intestinal lesion scores of sacrificed birds were 1.27a, 0.20b, 0.17b and 0.20b on Day 17 for 0, 50, 100 and 150 ppm treatments, respectively ($P < 0.05$). Final (Day 28) bodyweight was 1.001a, 1.124b, 1.129b and 1.128b ($P < 0.05$) kg for the four respective treatments. The results of this study indicate that tylosin tartrate is effective for treatment of necrotic enteritis when administered in drinking water at a concentration of 50 to 150 ppm.

Key Words: Broiler chicken, Tylosin phosphate, Necrotic enteritis

PSA Processing and Products: Poultry Meat Quality

566 The effect of stunning and decapitation on broiler activity during bleeding, blood loss and carcass quality. W. D. McNeal* and D. L. Fletcher, *University of Georgia, Athens, GA USA*.

Four experimental trials were conducted to determine the effects of stunning (14 volts, 500 Hz) and decapitation on bird activity during bleeding, blood loss, and carcass quality. Birds were subjected to modified Kosher killing (no stun, unilateral neck-cut), conventional killing (stun, unilateral neck-cut), decapitation without stunning, and decapitation following stunning. During bleeding, the birds were subjectively scored for severity of immediate reaction (0 to 10 s), intermediate activity (10 to 60 s), and late activity (greater than 60 s). Reactions and unconscious activity were scored as none (no visible reaction or only minor muscle quivering), mild to moderate (mild wing flapping and moderate spasmodic motion), or severe (violent wing flapping sufficient to cause major carcass movement or result in possible carcass damage). Birds were weighed before and after killing to determine blood loss. Carcasses were scored for completeness of picking, red wing tips, and red tails. Results showed dramatic differences in the severity of initial response and degree of unconscious activity during bleeding. Traditional Kosher killing resulted in little to mild initial response to the neck cut, followed by rather strong unconscious reactions at about 30 seconds post cut. Conventional stunning and killing showed almost no initial reactions and only mild intermediate or late reactions. Decapitation without stunning resulted in very strong immediate wing flapping and violent activity which steadily diminished in severity and which was almost completely ended by 45 to 60 seconds post-kill. Decapitation following stunning was similar to conventional stunning and killing with the exception of almost no late reactions at any level of severity. Compared to conventional slaughter, decapitation resulted complete cessation of movement after 60 s, a 0.2 % less blood loss (as measured by both the loss of blood and head), and no difference in carcass scores for feather retention, or red wings or tails. These results indicate that decapitation may be an effective means of slaughter following adequate stunning.

Key Words: Broiler stunning, Decapitation, Slaughter technology

567 Different attributes of breast meat quality in broiler great-grandparent lines. N. A. Gonet*, D. A. Sandercock, R. R. Hunter, and M. A. Mitchell, *Roslin Institute, Roslin, Midlothian, UK*.

Previous studies in our laboratory have shown that broiler great-grandparent lines (GGP) exhibit differences in muscle membrane integrity and stress sensitivity. It is not known if these differences influence meat quality (MQ). This study examined 3 commercial GGP lines in terms of both appearance and physical properties of their breast meat. The 3 lines (A, B and C) which differed according to their genetic origins and recent selection history were compared. Birds were reared under standard commercial conditions. At six weeks of age, all birds were killed in a commercial processing plant, chilled for 24 h at 4°C after which both breast fillets were cut from the carcass, weighed and frozen. Fillets were thawed at 4°C and estimates of water loss (thaw loss) were obtained. Meat color (lightness, redness and yellowness), extent of hemorrhaging and shear strength were also determined. Statistical analyses included (ANOVA and t-tests). Line B had highest body and fillet weights ($p < 0.01$) though C had highest %breast meat yield ($p < 0.01$). Fillets from lines B and C were the most red in color and exhibited a greater incidence of hemorrhaging ($p < 0.001$ vs. A). There were significant differences in meat lightness across the 3 lines ($p < 0.001$), line C being the lightest ($p < 0.001$) and most yellow in color ($p < 0.001$). Line C exhibited greatest water loss on thawing ($p < 0.001$). Shear force values were higher in lines A and C compared to line B ($p < 0.001$). The results show that differences in MQ attributes can be detected between commercial GGP lines which maybe indicative of genetic differences. Birds with higher %breast meat yields (line C) produced lighter colored, firmer meat with greater water losses. The heaviest line had more tender, redder meat with more extensive hemorrhaging. Understanding cellular mechanisms that lead to these differences in meat characteristics of broiler GGP lines may provide insights into the genetic origins of MQ which can lead to novel methods for genetic selection for improved muscle and meat quality.

Key Words: broiler, meat quality, genetic selection

568 Effect of Dietary Sorghum Cultivars on the Storage Stability of Cooked Broiler Breast and Thigh Meats. D. U. Ahn*¹, M. Du¹, K. C. Nam¹, and G. Cherian², ¹*Iowa State University*, ²*Oregon State University*.

A total of 150 day-old male broiler chicks (50 birds/pen, 3 pen/treatment) were fed corn-soy- flax meal-based diet (Control) with added sorghum at 10%. Two cultivars of sorghum (Ruby Red and Dekalb) were used for the study. Birds were slaughtered at the end of 42-day feeding trial. Twelve birds from each treatment (4 per pen) were randomly selected, and boneless, skinless breast and thigh muscles were collected. Breast or thigh meats were ground twice through a 3-mm plate, and patties were prepared. Patties were individually put in zipper bags, irradiated at 0 or 2.5 kGy, and cooked in a 90C-water bath to an internal temperature of 75C. At day 0 and 5 of storage, the TBARS of cooked patties were analyzed. Vacuum-packaged cooked patties were used to determine time- dependent volatile production during 12-h holding time. Meat from birds fed Dekalb had higher storage stability than those fed the control or Ruby Red diet. Irradiation had significant effect on the TBARS of cooked breast and thigh meats from Dekalb at Day 0. The aldehydes and sulfur compounds of cooked breast meat were lower in Dekalb compared with Control or Ruby Red. The content of total volatiles in thigh meat was not influenced by the dietary treatments. The results indicated that feeding Dekalb sorghum to broiler diet can improve the storage stability of cooked meat.

Key Words: Dietary Sorghum, Cooked Broiler Meat, Storage Stability

569 Antemortem holding temperature effects on broiler processing shrink, yield and breast meat quality. M. Petracci², D. L. Fletcher*¹, and J. K. Northcutt¹, ¹*University of Georgia, Athens, GA USA*, ²*University of Bologna, Bologna, ITALY*.

The influences of antemortem holding temperatures on broiler live shrink, processing yields, and breast meat quality were evaluated. In each of three independent trials, approximately 210 broilers were grown to 45 days using standard production practices. Prior to slaughter, the birds were individually weighed, placed in coops, and held for 12 h without access to feed and water. The coops were randomly divided into one of three groups and held at either 25, 29.5, or 34 C. For processing, the birds were first weighed live just prior to shackling, and the carcasses weighed following picking, evisceration, and chilling to determine live shrink and processing yields. Breast meat was removed at 2 or 24 h post-mortem for pH, R-value, sarcomere length, meat color, cooked yield, and shear value determinations. Birds held at 34 C had the greatest live shrink, 5.7%, compared to 3.9 and 3.2 % for those held at 29.5 or 25 C, respectively. Birds held at 34 C had lower processed carcass yields based on initial catch weight, but when calculated using post-shrink weights, there were no significant differences. For breast meat harvested at 2 h post-mortem, birds held at 25 C had higher R-values, redness, and yellowness values and lower cooked meat yield and shear values. For breast meat harvested at 24 h post-mortem, birds held at 25 C birds had higher pH, R-values, and redness. These results indicate that holding conditions may dramatically effect live bird shrink and yields, but have little effect on subsequent breast meat quality.

Key Words: Live bird holding, Processing yields, Breast meat quality

570 Marination of PSE broiler meat using non-meat binders. L. C. Cavitt* and C. M. Owens, *University of Arkansas, Fayetteville, AR, USA*.

In recent years, the poultry industry has seen a significant increase in the incidence of pale, soft, and exudative (PSE) meat exhibiting characteristics unsuitable for further processing due to excessive variation in meat color, poor meat binding, and decreased water holding capacity. Incorporating different non-meat binders into whole muscle products may be an effective way to improve water holding capacity of PSE meat. In this study, soy protein, whey protein, and modified food starch non-meat binders were vacuum tumbled with PSE and non-PSE meat. A total of 150 fillets (75 pale and 75 normal) were collected from a local processing plant. Meat color (L*value) and muscle pH were measured on each fillet at 24h postmortem. The fillets were then tumbled with a marinade using water only or water plus NaCl (0.6%), sodium tripolyphosphate

(STP) (0.3%) and either a soy protein isolate (SPI), whey protein isolate (WPI), or modified food starch (MFS) at 2%. Fillets were vacuum tumbled with a 20% marinade (based on meat weight) for 45 min in a 4 C cooler, stored at 4 C overnight, and then cooked. Marination retention and cook loss were determined. As expected, the pale fillets had significantly higher L^* values and lower pH values compared to the normal fillets. Marinades containing the SPI, WPI, or MFS improved water holding capacity compared to either the STP-control or water-only control as indicated by significantly lower cook losses. Furthermore, fillets marinated with MFS had significantly lower cook losses compared to all other treatments. Marinating with the MFS further improved water holding capacity of the pale fillets to the level of the normal colored fillets as indicated by no significant difference in cook loss. These results suggest that using modified food starch in commercial marinade solutions can enhance water holding capacity in broiler breast fillets including those that are PSE.

Key Words: PSE broiler meat, Marinade, Water holding capacity

571 Tenderness of chicken breast fillets processed in a commercial air-chill facility. L. J. Bauermeister*, S. J. Lewis, A. Velsquez, M. Tamayo, A. Aguilar, and S. R. McKee, ¹University of Nebraska-Lincoln Lincoln, NE..

The goal of this study was to determine the optimal deboning time for commercially air-chilled (AC) poultry. Deboning breast fillets from carcasses early post-mortem (PM) has been shown to cause meat toughening. However air chilling may alter rigor development thereby altering the PM aging period needed to prevent meat toughness. Birds from a commercial air-chilled facility were deboned at 2, 4, 6, 8, 10, 12, 14, 16 and 24 hrs PM (n=6 x 2 replications) and stored on ice at 4 C. Immersion-chilled (IC) fillets were purchased at a local grocery store (n=20 x 2 replications) and used as a comparative measure. Samples for pH and shear values were taken at each deboning period and cook loss was also determined. Results indicated pH reached 6.00 by 2 hrs PM, and by 4 hrs PM an ultimate pH of 5.85 was reached. This pH was maintained through 24 hrs PM. The average shear value of AC breast fillets decreased from 2 to 4 hrs PM with shear values of 7.40 kg/g and 4.10 kg/g respectively. Aging prior to deboning past 4 hrs PM did not result in any further improvements in meat tenderness for AC breast fillets. Store bought IC breast fillets had shear values of 10.15 kg/g. Commercial processing facilities often debone at 2 to 4 hours PM. Cook loss was determined after fillets were cooked in cook-in bags to an internal temperature of 76 C and cooled to room temperature before weighing. In general, the average cook loss for AC breast fillets decreased the longer the muscle stayed on the carcass and was lower than the cook loss of the IC fillets. The results of this study suggest that AC breast fillets could be deboned as early as 2 hrs PM without compromising meat tenderness.

Key Words: Air-chilling, Poultry meat quality, Aging on carcass

572 Rigor development and meat quality of large and small broilers and the use of Allo Kramer shear, needle puncture, and razor blade shear to measure texture. L. C. Cavitt*, C. M. Owens, J. F. Meullenet, R. K. Gandhapuneni, and G. W. Youm, University of Arkansas, Fayetteville, AR, USA.

In two trials, 150 female and male broilers of different sizes in each sex (large or small) were obtained from a commercial grower and were commercially processed to evaluate rigor development and texture. Breast fillets were excised at 0.25, 1.5, 3, 6, and 24h postmortem (PM). Muscle pH and L^* value was determined for each deboning time. Breast fillets were aged on ice until 24h PM, cooked to 76C, cooled, and then analyzed for texture using either Allo-Kramer (10 blade), needle puncture (2 mm), or razor blade shear (8 mm width) methods. Allo-Kramer tests were performed on intact muscles. Body size or sex had no effect on rigor development or color as indicated by no significant difference in breast muscle pH or L^* value through 6h PM. All three instrumental methods evaluated showed significant shear value differences between samples deboned at 0.25 or 1.5h PM and 3, 6, and 24h PM. A three way analysis of variance using sex, body size, and deboning time as main effects explained a small percentage of variation of the Allo-Kramer shear values ($R^2=0.46$), needle puncture energy ($R^2=0.26$) and razor blade energy ($R^2=0.46$). From these results, it would seem that both Allo-Kramer shear and razor blade tests performed similarly for differentiating breast meat toughness though Kramer shear force and razor blade energy were

weakly correlated ($r=0.65$). While both instrumental tests were performed in the same vicinity on each breast, it is possible that variation within the breast would have caused this marginal correlation. Although further studies would be necessary to compare the performance of both tests for assessing poultry meat toughness, the proposed razor blade test has the advantage of requiring no sample preparation (i.e. cutting of a strip of constant dimensions) other than cooking.

Key Words: Poultry meat, Texture analysis, Rigor development

573 The Effects of Raw Broiler Breast Meat Color Variation on Marination and Cooked Meat Quality. M. Qiao¹, J. K. Northcutt*¹, D. L. Fletcher¹, and D. P. Smith², ¹The University of Georgia, ²USDA-ARS, Russell Research Center.

Experiments were conducted to determine the effect of raw broiler breast meat color variation on marinated and cooked meat quality. In each of three independent trials, fillets were collected from a commercial deboning line based on breast meat lightness as follows: 30 fillets lighter-than-normal (lightness, $L^* > 53$), 30 normal fillets ($48 < L^* < 53$), and 30 darker-than-normal ($L^* < 46$) fillets. Within each color division (light, normal, and dark), 3 replicate groups of 10 fillets were individually weighed and marinated (20% marinate, wt:wt). Following marination, fillets were weighed to determine marinate uptake, held for 24 h at 2 C and re-weighed to determine marinate retention, cooked, and weighed again to determine cooked meat yield. The pH was determined on raw, marinated, and cooked samples. Color, moisture, and shear were measured on cooked meat. Results showed that breast meat identified by color differences affected meat pH, marination, marination retention, cooked yield, and texture but had no effect on cooked meat moisture content. Raw meat color differences were retained even after marination and cooking. There were significant negative correlations between meat lightness and pH; however, raw muscle pH did not correlate with final product moisture and shear. A positive correlation was observed between raw muscle pH and meat yield, but a negative correlation was found between pH and marination pickup. These results indicate that the pH variation associated with raw breast meat of different color can affect marination and cooked meat quality.

Key Words: Broiler, Breast meat color, Marination

574 The relationship of chilling time and temperature on quality of turkey pectoralis. C. Z. Alvarado*¹ and A. R. Sams², ¹Virginia Tech, ²Texas A&M University.

Pale, soft and exudative meat is a growing problem in the turkey industry. The objectives of this study were to determine the relationship between chilling rates and development of PSE-like conditions. At 22.5 wk of age, 96 Nicholas toms were conventionally processed in two trials, chilled for 45 min or 90 min in 0, 10, 20, or 30 C chill water, and deboned at 60 min or 105 min PM. Temperature and pH of fillets were recorded at 15 min PM, deboning, and 24 h PM. At deboning, L^* value, cook loss, gel strength, total protein solubility and bound phosphorylase were determined. At 24 h PM, cook loss, gel strength, and L^* values were determined. At 15 min PM, there were no differences in pH among treatments. At 60 and 105 min PM, the 30 C chilled carcasses had significantly lower pH compared to 0 C. All carcasses chilled at 30 C had the lowest pH at 24 h PM. In fillets deboned at 60 min PM, L^* value and cook loss were significantly higher and gel strength significantly lower in 30 C chilled carcasses compared to 0 C. At 24 h PM, there were no differences in L^* value and cook loss in fillets deboned at 60 min PM; however, gel strength was lower at 20 C as compared to 0 C chilled carcasses. Fillets deboned at 105 min PM had significantly lower L^* values when chilled at 0 C compared to 10, 20, and 30 C. The 20 C chilled carcasses had softer gels compared to 0 C chilled carcasses, and the 10 C chilled carcasses had higher cook loss compared to those chilled at 0 and 20 C but were not different from 30 C. At 24 h PM, cook loss was significantly lower in carcasses chilled at 0 C compared to the remaining treatments, however there were no differences in L^* value and gel strength. There were no differences in total protein solubility among treatments. However, there was a higher amount of bound phosphorylase present at 60 min and 105 min PM in 30 C chilled carcasses compared to the remaining treatments. Therefore, chilling carcasses at higher temperature for longer periods can result in poor meat quality.

Key Words: PSE, Chilling, Turkey

575 Skin Color Evaluation in Broilers Fed Natural and Synthetic Pigments. S. M. P. Castaeda*, E. M. Hirschler, and A. R. Sams, *Texas A&M University, College Station, TX.*

Broiler carcass skin color is important in the USA and Mexico. Because pigments are expensive, this study evaluated the use of natural and synthetic pigments in broiler diets at commercial levels. In two trials, 280 chicks were randomly distributed (20 birds each) into seven treatments according to the pigment class (natural or synthetic) and the inclusion level (ppm of pigments) of yellow (apoester) and red (canthaxanthin) pigments. Two treatments were designed to mimic current commercial practices in the USA and Mexico. The treatments were: control (no pigment); natural-low level, natural-high level, synthetic-low level, synthetic-high level, a common USA level, and a natural-synthetic blend used in Mexico. Diets were started at week 3 and feed consumption, body weight, skin color, and blood pigment level were evaluated weekly from weeks 3 to 7. At 49 d of age the birds were processed and skin color was measured after picking and chilling. The natural pigments had consistently greater skin b^* values (yellowness) than the synthetic pigments. The high levels produced greater skin b^* values than the low levels, regardless of source. The synthetic pigments had a slower increase in skin b^* but reached the same level as the natural-low by 7 wks. There was no difference in skin a^* values (redness) due to pigment source or level or the age of the bird. By 7 wks, all pigment sources approached plateau levels in the blood but the synthetic pigment diet had higher blood levels of both yellow and red pigments than the natural pigment diets. Processing intensified skin yellowness and reduced skin redness. These data suggest that natural pigments were more efficient at increasing skin yellowness and that there were only small differences between high and low levels for each pigment source. This may allow a reduction in pigment use and feed cost to achieve the same skin acceptance by the consumer. color, pigment, carotenoid, skin, broiler

Key Words: Color, Pigment, Carotenoid

576 Mechanisms of pink color formation in irradiated precooked turkey breast. K. C. Nam*, M. Du, H. Ahmed, S. J. Hur, Y. H. Kim, and D. U. Ahn, *Iowa State University.*

Irradiation produces pink color defect in precooked poultry breast meat. The chemical pigment form of the pink color in irradiated, precooked poultry meat has not been identified. According to our preliminary study, irradiation decreased oxidation-reduction potential (ORP) and produced gas compounds that can act as a sixth ligand of heme pigments. Therefore, we hypothesize that production of certain gas compounds and increased reducing conditions induced by irradiation may be responsible for the red/pink color formation in precooked irradiated turkey breast. The objectives of our study were to characterize color compounds generated by irradiation, and to determine the effects of packaging and storage on color production in precooked turkey

breast. Precooked turkey breast muscles were aerobically or vacuum-packaged and then irradiated at 0, 2.5, or 5.0 kGy using a Linear Accelerator. The CIE color, reflectance, ORP, gas production, and lipid oxidation of samples were determined at 0, 7, and 14 days of storage. Irradiation dose-dependent increase of pink color was found in mainly vacuum-packaged samples, and the increased pink color did not decrease during vacuum-packaged storage. Irradiation decreased ORP and produced carbon monoxide (CO) indicating that the pink color of irradiated precooked turkey breast was caused by the decreased ORP and heme pigment-CO complex formation. The reflectance of meat and the absorption spectra of myoglobin solution derivatives supported that denatured CO-myoglobin would be the pigment responsible for the pink color in irradiated precooked turkey breast. Lipid oxidation was not directly related to the pink color intensity of precooked irradiated turkey breast.

Key Words: Irradiated color, Carbon monoxide, ORP, Precooked turkey breast

577 Effects of selected chemicals on red discoloration in fully cooked broiler breast meat . D. P. Smith*¹, J. K. Northcutt², and J. R. Claus³, ¹*USDA Agricultural Research Service, Athens, GA 30604*, ²*University of Georgia Department of Poultry Science, Athens, GA 30602*, ³*University of Wisconsin-Madison, Madison, WI 53706.*

Two replicate experiments were conducted to determine effects of selected chemicals on red discoloration in uncured, fully cooked broiler breast meat. Breast fillets and femurs were removed from commercial broilers after chilling. Fillets were finely chopped and the meat was divided into five portions for treatment additives: No additive (Control); 0.3% ascorbic acid; 0.3% citric acid; 200 ppm ethylenediaminetetraacetic acid (EDTA); and, 3% nonfat dry milk (NFDM). One g of bone marrow, prepared by chopping and grinding primary spongiosa from the femurs, was added to the middle of ten g portions of meat, which were then placed into each of five replicate tubes. Tubes were cooked to an internal temperature of 76.6 C, immediately cooled, and meat was removed. Color values (CIE L^* , a^* , and b^*) were measured in triplicate on the meat surface adjoining the marrow. Lightness (L^*) ranged from 45.5 to 51.3, redness (a^*) ranged from 23.4 to 28.9, and yellowness (b^*) ranged from 14.4 to 16.8. Citric acid ($a^* = 23.4$) and EDTA ($a^* = 23.8$) significantly ($P < 0.05$) reduced redness compared to Control values ($a^* = 27.4$). Neither ascorbic acid ($a^* = 24.8$) nor NFDM ($a^* = 28.9$) reduced redness values when compared to Control values, although ascorbic acid redness values were significantly lower than NFDM. These data show citric acid and EDTA significantly reduced redness in this experiment, whereas ascorbic acid and NFDM did not reduce redness values.

Key Words: Cooked breast meat, Red discoloration, Bone marrow

Animal Products in Today's Diet

578 The nutritional contributions of animal products to the US diet - The USDA Food Pyramid and Dietary Guidelines. Donald. J. McNamara, Ph.D.*¹, ¹*Egg Nutrition Center.*

Seems all one ever hears about dietary recommendations is "eat more whole grains, more fruits, more vegetables" and nary a good word about milk, beef, pork, chicken, eggs or the other animal products in the diet. Too many so called nutrition experts put animal products in the "bad food" group based on fat and cholesterol without recognizing the wealth of contributions these products make to a healthy and nutritious diet. There are good reasons why animal products hold important places in the USDA Food Guide Pyramid and in the Dietary Guidelines for Americans, and no matter what the fat/cholesterol-phobic and animal rights activists say, the evidence is clear that the diet is more nutritious, and more enjoyable, with the inclusion of animal products in a balanced diet.

Key Words: Animal products, Nutrition, Dietary guidelines

579 Modified protein diets. E. Hentges*, *National Pork Producers Council.*

Diets higher in protein have gained popularity in the U.S. and other developed countries for several reasons. Hentges will discuss the protein diet effects on insulin resistance, serum lipids, and weight control. He will also discuss the effects this diet has had on the industry and the response from national health organizations.

Key Words: Protein, Diets

580 Designer foods. D.C. Beitz* and T.J. Knight, *Iowa State University.*

Governmental agencies and human health associations have made specific and general recommendations for consumers to improve their health by changing their diet. Animal scientists have responded with a variety of nutritional, genetic, and management tools that can be used to redesign meat, milk, and eggs compared with previously produced products. But, to continue to meet consumer demands and to make animal-derived foods even more appealing, animal scientists must continually strive to modify animal food composition and quality to meet

the evolving recommendations being offered. Although, most modifications address a specific recommendation, other characteristics of the products may also be negatively altered. For example, should production systems be modified to increase the polyunsaturated fatty acids, conjugated linoleic acids (CLA), and omega-3 fatty acids and how will these changes affect shelf-life of the products? Should we attempt to decrease cholesterol content of animal foods? How can animal-derived foods be modified to contain greater concentrations of endogenous and of exogenous compounds to improve healthfulness of the resulting foods? Experiments that result in greater concentrations of polyunsaturated fatty acids including CLA and omega-3 acids and lesser total fat content in animal foods will be described. The influence of dietary fats and vitamin D on food quality, specific breeding programs, and molecular biological procedures that can be used to make specific changes in composition of animal foods will be described and specific examples will be given.

Key Words: Designer foods, Food quality, Fat composition

581 Designer foods: egg products. Hilary Shallo*, *Egg Nutrition Center.*

Last year, 158 million American - 85% - used a dietary supplement. Whether to simply maintain health or manage/treat a condition, nine out of ten shoppers prefer naturally nutritious foods to supplements (FMI/Prevention, 1999; HealthFocus 1999). In its efficient ovoid container, eggs are naturally a functional food providing valuable nutrients, from their high-quality protein to significant levels of beneficial vitamins, antioxidants, and other healthful compounds. In addition to the eggs being a natural functional food, the egg's nutrient content can be altered by the feed given to chickens. Consumers can now find eggs with even less cholesterol and saturated fat than typical and with an added bonus of increased vitamin E and DHA. And processors are beginning to make similar products available on an industrial level. Dr. Hilary Shallo will discuss the new nutrient-enhanced egg products that are available in the marketplace.

Key Words: eggs, designer eggs

582 Dairy Foods and Ingredients - Nutritious and Functional Products for the Food Industry and the Consumer. P. Tong*¹ and C. Podgurski¹, *¹Dairy Products Technology Center, California Polytechnic State University.*

Milk and the products made from milk are known to offer consumers good nutrition and good taste. Technologies continue to improve for the

processing of milk into highly functional dairy ingredients for the food industry. In addition, consumer interest in health promoting foods is increasing. As a result dairy ingredients are widely used in formulating baked goods, nutritional beverages, confections, sauces and other foods for today's consumers. As our understanding of the biological function of individual milk components improves, a whole new line of bio-active, functional dairy foods and ingredients are emerging. These specialized dairy ingredients are being used in foods which are thought to improve overall health (e.g., immune function, intestinal health, blood pressure regulation, etc.).

Key Words: dairy foods, milk, nutrition

583 Product Overview: Meat Products. D. H. Beermann*, *University of Nebraska, Lincoln.*

Linkages between nutrients in foods and human health have long been used as a basis for dietary recommendations. The Dietary Guidelines and the Food Guide Pyramid provide guidance through identity of basic food groups and suggested relative daily intakes. Concerns about total fat, saturated fat, and cholesterol content of meat and meat products spurned suggestions in the 1980s and 1990s that intake of meat and meat products be reduced. Although these recommendations lacked credence because daily contributions to the diet relative to dietary guidelines were not described for meat and other foods, consumers responded to these suggestions. This prompted research investigations directed at discovering strategies or technologies that improve fat-to-lean ratio, fatty acid composition, and altered concentrations of other nutrients. Success in altering carcass and retail cut composition was achieved through genetic selection, genomic analysis, administration of metabolism modifiers (somatotropin, beta-adrenergic agonists, conjugated linoleic acid (CLA)) and improving diet formulations to more closely match nutrient requirements of livestock. Technologies were developed for reducing fat content and altering nutrient composition of manufactured meat products. Examples of these are discussed. The discovery of the anti-carcinogenic, anti-tumorogenic, anti-diabetic effects of the cis-9, trans-11 isomer of CLA led to investigations of strategies for elevation of CLA concentrations in lipid depots of meat animals, primarily through dietary manipulation strategies. Feeding full-fat extruded soybeans at a level of 25% of the diet increased CLA cis-9, trans-11 15 to 20% in steers, but in other studies, feeding 6% yellow grease doubled concentration of the isomer. Comparison of results of several unpublished studies is presented.

Key Words: Designer Meat, Fat, CLA

Contemporary Issues in Sheep Production and Research

584 Outlook for wool markets in the 21st century. C. J. Lupton*, *Texas Agricultural Experiment Station, San Angelo.*

Wool's current market share of world fiber production is 3% with man-made fibers having 59% and cotton 38%. Raw material prices, processing costs, fashion trends, and fiber characteristics are all major factors in the global fiber competition for market share. In the past 15 yr, world production of wool has declined by 662 thousand tonnes from 3002 during the 1985/1986 season to 2340 in 1999/2000. During this time, production actually peaked at 3358 thousand tonnes in the 1990/1991 season. This high level of production, historically high prices, political and economic turmoil in the USSR and some eastern European countries, war in the Middle East, a drastic reduction in purchases by China, and the onset of recession in several major market countries combined to force suspension of the Australian Reserve Price Scheme in February, 1991, (a stabilizing factor on wool prices for the previous 17 yr). The concurrent accrual of a large wool stockpile (4.7 million bales in Australia alone) without price support resulted in an immediate downward adjustment in wool prices (35%). The effects of these events are still being felt. Slowly, the balance between supply and demand is being restored at price levels that will permit profitable production. Low prices have caused many producers to leave the sheep business. On the other hand, low prices have made wool more attractive to textile processors, and have helped wool retain some of its market share. Raw wool prices are now forecast to increase moderately over the next 10 yr because of lower supply, modest improvements in demand, and increasing numbers and affluence of consumers. In future, production and manufacturing

is expected to be concentrated in those countries that can produce and process it at the lowest cost. The high standard and cost of living in the US, high labor costs, increasing land values, greater public concern for the environment and the well-being of wildlife including predators, the expectation of younger generations for more comfortable lives, and sheep's inability to adapt well to large-scale, indoor factory operations all lead me to believe a decreasing proportion of wool and lamb will be produced domestically. Imports will supply the predicted moderate increases in demand by U.S. consumers for wool and lamb.

Key Words: Wool, Wool Markets, Sheep

585 Current status of genomic tools for genetic improvement in sheep. B. A. Freking*, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

Rapid accumulation of genomic sequence data from a variety of mammalian species has led to increased knowledge of the structural organization and function of genes which impact production traits in livestock species. Tremendous genetic variation exists within and between sheep breeds for many economically important traits. Identification of the specific allelic variation would allow efficient use of DNA-based technologies to enhance information used to predict breeding values. The existing genetic map based on microsatellites is useful for initial scans of the sheep genome, but lacks comparative information on positional candidate genes. Current efforts in gene discovery have generated substantial

numbers of expressed sequence tags (EST) for cattle and swine. Over 150,000 bovine and 50,000 porcine EST sequences are publicly available. The cDNA clones used to produce the EST sequences are also useful resources for the production of microarrays used to profile gene expression patterns. At MARC, primers designed to amplify genomic samples for mapping bovine and porcine EST sequences have also been successful in amplifying sheep DNA. To date, 276 bovine-derived and 128 porcine-derived EST primer pairs have generated sheep amplification products. Sequence variation between different animals in the form of single nucleotide polymorphisms (SNP) will be the future platform for high-throughput automated genotyping technologies and evaluation of marker associations of phenotypes and important genes. The sheep industry must focus on the relevant traits which improve the viability and efficiency of lean lamb production. Genomic tools are rapidly changing our ability to efficiently identify and utilize genetic variation.

Key Words: Sheep, Genetics, Genomics

586 Nutrient recommendations for sheep: gaps in information and future approaches. H.C. Freetly*, *USDA, ARS, Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE.*

Developing nutrient recommendations is an iterative process that involves taking available information, making a set of recommendations, testing the recommendations, and using the new information to refine the recommendations. The National Research Council last published its recommendations of sheep nutrient requirements in 1985. Given the

elapsed time, the question has been raised, do those recommendations need to be refined? Changes in the demographics of the sheep industry have resulted in changes in the types of sheep raised and management used. These changes have resulted in some deficiencies in the previous recommendations. Recommendations for the growing lamb do not take into consideration 1) decreases in maintenance energy with increased age, 2) the effect of previous nutrition on subsequent performance, 3) breed type differences, or 4) defined amino acid utilization. Recommendations for the ewe do not take into account 1) dynamic changes in body weight, 2) dynamic adjustments for gestation and lactation, 3) large litter sizes, and 4) defined amino acid utilization. Using the existing equations to predict nutrient recommendations for large lambs and ewes results in extending the input data beyond that used to parameterize the equations. Recommendations for mature rams are absent. Since the last recommendations were developed, a sparse amount of research has been conducted that addresses these deficiencies. This paucity of available research suggests that major changes in the system would be difficult to make. The mathematical structure of the system will determine what research needs to be conducted. The current recommendations are mathematically based on a net energy system. Alternative model structures can be used to develop the future nutrient recommendations. A consensus on the structure of the next mathematical model will provide guidance to investigators in their experimental designs that will allow them to focus their resources on collecting the information required to parameterize the system.

Key Words: Sheep, Nutrition

Animal Production and the Environment: Challenges and Solutions

587 CNMPs, TMDLs, CAFOs/AFOs, effluent guidelines, and other issues. T. Hebert*¹, ¹*Capitolink, LLC.*

Livestock agriculture faces enormous challenges and opportunities that are driven by events and programs at both the federal and state levels. Most of these are directly related to proposed and coming changes in key water quality regulatory policies. These include proposed rules for permitting of Concentrated Animal Feeding Operations (CAFOs) and their related Effluent Limitation Guidelines, Comprehensive Nutrient Management Plans (CNMP's), the final rulemaking on Total Maximum Daily Loads (TMDL's). In addition, the farm bill is also in the process of being re-authorized, and a key item for consideration is potential funding to help livestock producers manage manures more effectively and to protect water quality. The status of these matters, the outlook for their final disposition, and some key implications for the livestock sector will be discussed.

Key Words: CAFO, CNMP, TMDL

588 Challenges and opportunities facing animal agriculture: Optimizing nutrient management in the atmosphere and biosphere of the earth. E. B. Cowling*¹, ¹*North Carolina State University.*

Humans need food. Humans use energy. Production of food and combustion of fossil fuels increase concentrations of biologically active N in the atmosphere, soils, and surface and ground waters of the earth. These increases are caused in part by demand for animal protein in human diets, increased use of synthetic N fertilizers, and widespread planting of N-fixing legumes. The world's crops, forests, and fisheries respond to N enrichment with some positive benefits (e.g., increased food, feed, timber, and fish production) and some negative consequences (e.g., acidification and eutrophication of aquatic and terrestrial ecosystems, decreased biodiversity, increased regional haze, global warming, and such human health impacts as nitrate contamination of drinking water and increased pulmonary and cardiac disease caused by exposure to toxic ozone and fine particulate matter).

So far, most pollution abatement strategies have aimed at resolving one or another pollution problem in which oxidized or reduced forms of N play an important part. The time has come to consider more fully integrated strategies by which N management practices can be optimized to increase agricultural, forest, and fish production while decreasing N-induced soil-, air-, and water pollution.

The challenges and opportunities facing animal agriculture include joining with EPA, university, and other stakeholders in: 1) making realistic assessments of actual positive and negative impacts of N and particulate

matter emissions from animal agriculture, and 2) developing practical (economic) guidelines and strategies for: a) minimizing use of fossil fuels in agriculture, b) improving feed conversion efficiency in poultry, egg, swine, cattle, and dairy production, c) conserving and reusing valuable nutrients in animal wastes, d) minimizing N and P losses from manures, e) developing horizontally and vertically integrated systems of meat production and manure management through production and marketing of high-return value-added products.

Key Words: Atmosphere, Biosphere, Nutrient Management

589 Animal production impacts on nitrogen emissions to air and ground water: a Dutch case with a European perspective. Wim de Vries*¹, Hans Kros¹, Oene Oenema¹, Gert Jan Reinds¹, and Max Posch², ¹*Alterra Green World Research, Wageningen, the Netherlands.* ²*National Institute of Public Health and the Environment, Bilthoven, the Nether.*

In the Netherlands, intensive animal husbandry has led to very high N emissions into the environment. The estimated total annual N input flux per hectare on agricultural land for the year 1997 is 485 kg for the Netherlands compared to 146 kg for the European Community. The animal manure production in the Netherlands is approximately 5 times the average European value (265 kg compared to 56 kg) and the same holds for the N surplus (256 kg compared to 52 kg).

To gain insight in the fate of N input in the Netherlands, a study was carried out analysing the nitrogen fluxes for 250 × 250 m² grid cells with a simple N balance model representing all crucial processes in the N chain. Results of average annual fluxes (kton N.yr⁻¹) for the year 1997 equalled 1077 for the total N input and 261 for the total N emission to air, ground water and surface water, i.e. 140 for NH₃ emission, 103 for N leaching and 18 for runoff to the sea.

Despite the relative low N leaching and N runoff compared to the N input, it does cause an excess of critical limits for nitrate in ground water (50 mg.l⁻¹) and nitrogen in surface water (2.2 mg.l⁻¹) in large parts of the Netherlands. We calculated the maximum allowable nitrogen application on the basis of the critical limits given above and the acceptable ammonia emission related to the protection of biodiversity of natural areas. Results showed a reduction of 50 to 70% is needed to reach the ceilings necessary to protect the environment against all adverse impacts.

On a European scale NH₃ emissions are the major cause of elevated N deposition. Results of atmospheric deposition measurements at 317 forested plots, mostly concentrated in central Europe, showed that more

than 50% of the investigated plots received a nitrogen input above a deposition level at which the species diversity of the ground vegetation may be at risk.

Key Words: Nitrogen, Critical loads, Animal production

590 The role of nutrition in reducing nutrient output from ruminants. L.D. Satter*¹, T.J. Klopfenstein², and G.E. Erickson², ¹*U.S. Dairy Forage Research Center, Madison, WI*, ²*University of Nebraska, Lincoln*.

Much of the effort expended on nutrient management has focused on the post-excretion product. It is important to keep in mind that management of the diet can have important impacts on quantitative and qualitative aspects of the excreted nutrient. Surveys of nutritionists and extension specialists show that dairy producers are advised to feed .45-.50% phosphorus (P)(DM basis) in their lactating cow diets. This is 20-30% in excess of NRC (2001) requirements. Feeding to requirement would reduce P excretion by 30% or more, and would reduce solubility and potential for runoff of the P that is applied to fields. Nitrogen (N) excretion by dairy cows can also be decreased, but by a lesser amount. Balancing RUP and RDP, and use of protected methionine along with strategic selection of protein supplements that are relatively rich in lysine, may permit a 10-15% reduction in total N excretion, with most of the reduction occurring in urinary N. Urinary urea, following conversion to ammonia, is the N excretion product most vulnerable for loss to the environment. Feedlot cattle routinely consume P in excess of NRC (1996) predicted requirements, and recent research suggests the NRC estimates of the P requirement are high. Decreasing dietary P from the industry average (.35% P) to the NRC predicted requirement (.22-.28%) decreased P input by 33 to 45% and excretion by 40-50% in nutrient balance studies. With grain-based feedlot diets, overfeeding P is inevitable. At minimum, supplemental P sources should be removed from diet formulations. More accurate formulation of feedlot diets for protein provides opportunity for reducing N excretion. Using the NRC model for metabolizable protein, and employing phase-feeding, N inputs may be decreased by 10-20% from the feedlot industry average of 13.5% dietary CP. This translates into a 12-21% reduction in N excretion, and 15-33% reduction in ammonia volatilization in open-dirt feedlot pens. Diet formulation can have important impact on the amount of N and P excreted in both dairy and beef. It is much easier to control potential pollutants by managing their release into the environment than to recover or confine them once they are released.

Key Words: Nitrogen, Phosphorus, Ruminant

591 Nutritional strategies to reduce environmental emissions from non-ruminants. P.R. Ferket*¹, R.C. Angel², E. van Heugten¹, and T.A. van Kempen¹, ¹*College of Agriculture and Life Sciences, North Carolina State University, Raleigh, NC 27695*, ²*Department of Animal Science, University of Maryland, College Park, MD 20742-2311*.

The amount of nutrients (i.e. N, P, Zn and Cu) and associated odors emitted from production animals into the environment can be modulated by several different nutritional strategies, but their practical application is dependent upon costs and other biological limitations. In general, nutrient excretion may be reduced by avoiding the feeding of excessive amounts or using nutritional manipulations to enhance nutrient utilization in the animal. Manufacture and handle feed to minimize wastage and improve feed/gain. Develop feeding programs that are specific for sex and strain of animal, increase the number of feed phases,

and formulate diets according to the minimum nutrients required to satisfy production goals. Use the ideal protein concept to estimate amino acid requirements and use synthetic amino acids supplements to reduce N emission. Use feed ingredients with high digestibility and nutrient bioavailability, and formulate diets based on nutrient availability instead of total nutrient content. Nutrient digestibility of feedstuffs is dependent upon processing conditions, genetic characteristics of the grains and oilseeds, and the presence of nutritional antagonists in the diet. Avoid feed ingredients that lead to odor production (e.g. fishmeal and some easily fermentable feed ingredients). Use feed additives, such as antibiotics, nonstarch polysaccharides, direct-fed microbials, organic acids, microbial enzymes (i.e. phytase, carbohydrases, and proteases) to increase the digestibility and absorption of nutrients or to modulate microflora. Finally, a cost factor for the control or disposal of nutrients or odor should be considered in the feed formulation to optimize the various nutritional strategies discussed above. Regardless of biological and economic limitations, significant reductions in nutrient and odor emission from non-ruminants can be achieved by appropriate nutritional strategies.

Key Words: nutrition, nutrient and odor emission, non-ruminants

592 Development of comprehensive nutrient management plans: Practical aspects of getting nutrient management plans implemented . Mary Combs*¹, ¹*USDA-Natural Resources Conservation Service, Raleigh, NC*.

The 1998 Clean Water Action Plan required the EPA and USDA to jointly develop a unified strategy to minimize the environmental and health impacts of the nation's animal feeding operations (AFOs). This Unified National Strategy for Animal Feeding Operations identified a national expectation that all AFOs develop and implement Comprehensive Nutrient Management Plans (CNMPs) by 2009. Focusing on the smaller, non-regulated (federal) AFOs with limited resources, NRCS and its partners may need to assist with an estimated 262,700 CNMPs across the U.S. to meet this expectation.

Significant CNMP development and implementation issues remain: (1) Substantial resources for staff and training are required to provide this accelerated technical assistance for CNMP development. Developing the CNMP is just the first step; considerable follow-up with producers is required to assist with operation, maintenance, and revision of the Plans as producers' needs change. (2) More research is needed in several critical areas to better understand nutrient movement and validate states' phosphorus indexes and models that assess potential nutrient losses. (3) In areas of concentrated AFOs and limited land for application, nutrient management policy may result in no technically or economically feasible solutions for the producer. (4) Both regulators and technical specialists must recognize the economic situation of producers. The cost of waste management systems is site specific, and is not only a function of operation size. The special challenges to limited resource farmers must be considered. (5) Cost sharing and incentives are inadequate to meet the needs. In North Carolina, USDA's Environmental Quality Incentives Program and the N.C. Agricultural Cost-Share Program fund about 1/3 of the existing demand. (6) Ensuring compatibility with state programs, laws, rules, and certification criteria for technical specialists will continue to a significant coordination effort. (7) NRCS's image by its customers continues to evolve. NRCS practice standards, developed to support voluntary USDA programs, are becoming regulatory instruments, as federal or state regulations reference these standards.

Key Words: AFO, CNMP, NRCS

Novel Genes and Gene Products

593 Differential display as a tool to identify a steroid-induced gene. Robert Kempainen*, *Auburn University, Auburn, Alabama* .

Differential display is one of several methods designed to identify differentially induced or expressed genes and has been used successfully in many studies to identify new genes in various tissues or cells. The basic method involves collection of RNA from target tissues followed by cDNA synthesis using oligo-dT primers designed to make cDNA from subpopulations of the mRNA. These different cDNA's are then used as templates in PCR in conjunction with the original oligo-dT primer and

a set of arbitrary upstream primers. Labeled PCR products are loaded onto sequencing gels so that side-by-side comparisons can be made to identify up- or down-regulated genes. We used the technique to identify dexamethasone-induced genes in a pituitary cell line. Since steroid negative feedback requires gene transcription/translation and the identity of steroid-induced genes is unknown, differential display seemed to be an ideal technique for this purpose. Cells were treated with dexamethasone or its vehicle and RNA was collected and used for differential display. The screen performed used 240 primer combinations, surprisingly; only about 20 induced bands were consistently generated. Of the

20, 19 turned out to be false positives and one dexamethasone-induced gene was identified; its full-length cDNA was cloned from a library and sequenced. The cDNA is a novel member of the Ras-superfamily and was named *Dexas1* due to its ability to be induced by dexamethasone. Experiments are in progress to characterize the role of *Dexas1* in the pituitary and in other steroid-responsive tissues. Overall, differential display was extremely useful in identification of a novel gene, however, it may require considerable effort in terms of testing various PCR primer combinations and the technique may be expected to generate a significant number of false positives.

Key Words: Differential , Display, Dexamethasone

594 Genes, Chips and Animal Biology. Nagappan Mathialagan*¹, Charles Bolten¹, Steven Wagner¹, John Byatt¹, and Frances Buonomo¹, ¹*Monsanto Animal Agricultural Group.*

Genomic technologies have transformed the animal biology research into a new era of discoveries in a similar fashion as the introduction of radioimmunoassay techniques. Genomics has resulted in the identification of thousands of new gene sequences in farm animal species with no real link to functional association. Comparative genomic analysis with completed genomes such as human has been used to discover orthologous genes. However, this approach still leaves out the annotation of genes which are novel to the animal species. Gene expression technologies like Microarrays and Serial Analysis of Gene Expression (SAGE) are used to determine the expression of thousands of genes simultaneously. Species-specific microarrays need to be used to associate a function to these new genes. However, cross-species microarrays may be used in instances where there are no species-specific arrays. We have used Incyte human microarrays for transcript profiling of bovine mammary gland to identify regulated genes associated with milk production. A set of human gene homologues were identified that are regulated during lactation and involution. Genes up-regulated during lactation, identified by heterologous profiling, were selected for confirmation by other methods such as Northern blot analysis, quantitative RT-PCR, subtractive cDNA libraries and nylon arrays. One example of a regulated gene we selected for confirmation was Stearoyl-CoA-Desaturase (SCD), an enzyme involved in the synthesis of conjugated linoleic acid. An increased expression was associated with lactation while a sharp decline in the expression was observed with involution. In addition, our experience with

heterologous arrays showed that genes can be erroneously identified due to sequence identity of bovine genes to unrelated genes in human. This observation emphasizes the preference to use species-specific arrays for gene expression studies.

Key Words: Transcript Profiling, Microarrays, Genomics

595 Proteomics in the animal sciences. Lawrence Dangott*, *Texas A&M University, College Station, TX.*

One of the goals of biologists in the post-genome era will be to characterize all the proteins within an organism, tissue or organelle, in order to describe the pathways and protein interactions that mediate cellular function. Proteomics is the term given to the large-scale analysis of proteins using biochemical, biophysical and chemical techniques of analysis. Although traditionally associated with the two-dimensional display of large numbers of proteins, in the post-genomic era, proteomics is dividing into three main areas; 1) protein identification and micro-characterization; 2) differential expression analysis of proteins in normal and altered tissues; and 3) studying protein-protein interactions. Approaches to achieve these goals require the combination of traditional molecular biological, biochemical and biophysical techniques with the expanding capabilities of high-throughput robotics and high-sensitivity, high-resolution mass spectrometry as well as the development of new technologies. These kinds of approaches are being used in our laboratory and others to explore and explain the functions, interactions and regulation of proteins in animal reproductive biology and environmental toxicology. Proteins involved in embryo implantation are being identified in ovine uteri using 'knock-out' ewes, two-dimensional gels and in gel digestion techniques coupled to automated protein micro-sequencing and MALDI-TOF (matrix-assisted laser desorption ionization time-of-flight) mass spectrometry. Similarly, proteins involved in horse sperm differentiation are being identified by applying these techniques to proteins isolated from in vitro cultures of equine seminal tubules. In related experiments, post-translational modifications are being mapped by ion-trap electrospray mass spectrometry and multi-dimensional chromatography coupled with mass spectrometry is being used to identify components of protein complexes.

Key Words: Proteomics, Mass spectrometry

Preharvest and Postharvest Approaches to Modification of Milkfat

596 The milk fat globule membrane of buttermilk: a unique ingredient. M. Corredig*, *Department of Food Science and Technology, University of Georgia.*

The presence of material derived from the milk fat globule membrane (MFGM) makes buttermilk (the byproduct of buttermaking) distinct from any other dairy product. Studies of MFGM have revealed strong associations of the membrane lipids with various membrane proteins (butyrophilin, xanthine oxidase and some minor proteins). When membrane material is isolated from buttermilk a high ratio of polar lipids is found, in particular phosphatidyl ethanolamine, phosphatidyl choline and sphingomyelin. Phospholipids play an important role in many metabolic processes, and phospholipid-enriched fractions are today marketed as important ingredients in a variety of dietary products. Furthermore, evidence is emerging that sphingomyelin from milk may have anti-cancer properties and other health-related benefits. In addition to

the nutritional quality of MFGM, a more detailed analysis of the composition of buttermilk has suggested the utilization of buttermilk as an ingredient in the manufacture of foods, for example low fat cheese and yogurt. The behavior of buttermilk as a functional ingredient can be attributed to the presence of skim milk proteins and the MFGM, however the role played by the various components and their interactions is not understood. Processing history and compositional differences also seem to affect the functionality of MFGM. Understanding the various components and the functional properties of buttermilk will allow this byproduct to become a source of new and unique ingredients. Our discussion will review the current literature in this area and present some thoughts on the further development of commercial products derived from the MFGM.

Key Words: phospholipids, MFGM, buttermilk

Role of Extracellular Matrix (ECM) in Growth and Development

597 The role of the extracellular matrix in growth and development: An introduction. M.W. Orth*, *Michigan State University.*

Besides providing structural support, the extracellular matrix (ECM) has recently been shown to play a significant role in the regulation of tissue growth and development. As an example, certain ECM molecules can sequester growth factors and release them during tissue remodeling. Also, proteolytic products of ECM molecules can have a unique biological activity via interactions with cell surface receptors. The focus of this symposium will be to examine the role and regulation of the ECM in four tissues of particular interest to the animal scientist. Dr. Sandy

Velleman will describe the architecture of the ECM in skeletal muscle tissue with an emphasis on the function of the proteoglycan component. The predominant focus on myofibrillar proteins traditionally has overshadowed this exciting area of research. Dr. Tom Schmid will discuss the role of the ECM during endochondral bone formation, with an emphasis on ECM proteins found in unique regions of growth plate and articular cartilage that were discovered in his laboratory. He will also discuss the potential of using ECM molecules as biological markers in physiological fluids to monitor the development and health of the skeleton. Dr. Russ Hovey will discuss the development of the mammary gland and its complex architectural structure. Specifically his research interest focuses on understanding the contribution of the mammary stroma dur-

ing mammary epithelial proliferation and function. Finally, Dr. George Smith will elaborate on his research into the role of matrix metalloproteinases and plasminogen activators in ovarian function. His laboratory has found that these two families of ECM proteinases are temporally and spatially regulated during the ovarian cycle and contribute to ECM remodeling associated with growth, differentiation, and resorption of ovarian structures. We hope that through this symposium animal scientists will gain a deeper appreciation for the ECM and how it could play a major role in understanding and solving some of the problems encountered in the animal science industry.

Key Words: growth, development, matrix

598 Role of the extracellular matrix in muscle growth and development. Sandra G. Velleman*¹, ¹The Ohio State University/OARDC.

Studies on the growth and development of skeletal muscle have predominantly focused on the myofibrillar components especially myosin and actin. It has been largely overlooked that skeletal muscle cells secrete a network of extracellular matrix macromolecules which have the potential to regulate the growth and development process. The extracellular matrix is composed of a network of glycoproteins, collagen, and proteoglycans that surround the skeletal muscle fibers. The positioning of the individual extracellular matrix macromolecules is not random, but instead the individual components interact to form a precise structural architecture which becomes the epimysium, perimysium, and endomysium skeletal muscle connective tissue layers. The extracellular matrix then functions by maintaining tissue shape and structure, regulating tissue function, and communicating information back to the cells through the formation of cell-extracellular matrix signal transduction pathways. Information communicated to the cell from the extracellular matrix may influence migration and adhesion, and proliferation and differentiation. As muscle ages, the composition of the extracellular matrix changes. During muscle formation, the embryonic extracellular matrix appears to be involved in the spacing of the developing muscle fibers and later in development changes to a matrix with macromolecular components involved in growth factor regulation. Although basic aspects of skeletal muscle extracellular matrix composition are known, it is not well understood how the extracellular matrix affects skeletal muscle development and function. Focus will be on the proteoglycan component of the extracellular matrix because of its role in regulating collagen fibrillogenesis, cellular growth properties, and cellular growth factor responsiveness.

Key Words: Muscle, Proteoglycans, Extracellular Matrix

599 Role of the extracellular matrix in skeletal growth, development and health. T. M. Schmid*, *Rush Medical College, Chicago, IL.*

The mass and volume occupied by the skeleton is primarily due to its abundant extracellular matrix (ECM). Research over the last 3 decades has characterized many skeletal macromolecules including classes of collagens, proteoglycans and glycoproteins. These molecules fulfill different structural functions, but also can exhibit regulatory roles. The ECM provides a scaffold for skeletal remodeling and acts as a reservoir for growth factors and nutrients. The matrix of cartilage and bone are distinctly different, however their calcified cartilage interface is surprisingly similar. The growth of this organ is orchestrated by a symphony of growth factors. The fine-tuning of this metabolic activity requires an information exchange at the cell-matrix interface. Cell surface receptors bind extracellular matrix ligands and generate intracellular signals, which direct cellular activities. Fragments of matrix macromolecules can modulate these interactions. The remodeling of the extracellular matrix in growth and development is a highly regulated process involving several classes of proteolytic enzymes. A variety of biochemical assays have been developed to study the synthesis and degradation of the extracellular matrix in cartilage and bone. Work in my laboratory has focused on the identification of macromolecules that are unique to specific regions of growth or articular cartilage. Type X collagen is the prototype of these molecules and is found almost exclusively at the interface of cartilage and bone. Another exciting molecule, which protects the articular cartilage surface, is superficial zone protein (SZP). This is a 345-kDa proteoglycan that is synthesized by superficial zone chondrocytes, but not deep zone chondrocytes. We have recently shown this molecule to be an abundant glycoprotein in synovial fluid and has lubrication activity when tested on a cartilage-glass interface. Another protein Dell

appears to be enriched in the superficial layer of articular cartilage and in the hypertrophic zone of the growth plate. Future studies will define if these molecules hold promise as biochemical markers to monitor the growth, development and health of the skeleton.

Key Words: Growth plate, Cartilage, Skeleton

600 Role of the stroma and extracellular matrix during mammary gland growth and development. R.C. Hovey*, ¹National Cancer Institute, NIH.

The normal mammary gland undergoes extensive development prior to assuming the ultimate lactogenic phenotype. Under hormonal regulation the mammary epithelium proliferates within the stromal matrix of the mammary fat pad, giving rise to an architecturally-complex and species-unique ductal network. These species differences reflect an altered abundance and proliferation of various stromal cell types (adipocytes, fibroblasts, endothelial cells) that intimately associate with myoepithelial and epithelial cells. Together these cells contribute the various elements of the extracellular matrix that regulate normal epithelial cell proliferation, differentiation and milk protein gene expression, and tumorigenesis and metastasis during breast disease. Historically, attention has focused on the function of mammary epithelial cells, independent of the stromal matrix. Our research has begun to explore the contribution of the mammary stroma during mammary epithelial proliferation and function. It is increasingly evident that cellular constituents within the mammary fat pad are integral sites of hormone action that mediate systemic signals through altered stromal proliferation and paracrine growth factor expression. Likewise, species differences in stromal function may confer differential morphogenesis to the mammary epithelium. In addition, development of the vasculature system within the mammary gland occurs within the mammary fat pad under hormonal and growth factor influences that converge during epithelial-stromal and extracellular matrix interactions. Although the mechanisms by which epithelial-stromal and epithelial-matrix-stromal interactions regulate mammary gland growth, morphogenesis, function and neoplasia have not been resolved, increasing evidence points to their integral function within the mammary gland.

Key Words: mammary, stroma, epithelial-stromal interaction

601 Regulation of extracellular matrix remodeling during the ovarian cycle: Implications for the control of growth, differentiation and resorption of specific ovarian structures. George W. Smith*^{1,2}, Mark P.D. Dow^{1,2}, Leanne J. Bakke², Will A. Ricke³, Carolyn A. Cassar¹, Michael W. Peters¹, J. Richard Pursley¹, and Michael F. Smith³, ¹Department of Animal Science, Michigan State University, ²Department of Physiology, Michigan State University, ³Department of Animal Science, University of Missouri-Columbia.

For many years, the ovarian extracellular matrix (ECM) was thought to function merely as scaffolding providing architectural support. However, a growing body of evidence indicates the ovarian ECM also plays a key regulatory role. In general, changes in the ECM can influence gene expression and cell migration, proliferation, differentiation and death. Within the ovary, changes in the ECM help regulate specific events during the ovarian cycle. Growth of bovine ovarian follicles from the primordial to preovulatory stage is characterized by an approximately 360,000-fold increase in surface area as follicles expand within the confines of the surrounding ovarian stroma (ECM). Ultimately, most follicles die by atresia and are resorbed. The remaining follicles undergo ovulation, characterized by follicle rupture and release of the egg. Follicle rupture is dependent upon localized degradation of the ECM at the apex of the preovulatory follicle wall. Extensive ECM remodeling is also characteristic of the luteal phase. Following ovulation, transformation of remnants of the preovulatory follicle into a corpus luteum involves mechanisms similar to wound healing and tumor formation. Disruption of cell-ECM contacts, loss of steroidogenic capacity, cell death and tissue resorption characterizes corpus luteum regression at the end of a nonfertile cycle. Two families of proteinases that regulate ovarian ECM remodeling are the matrix metalloproteinases (MMP) and the plasminogen activators (PA). The MMP are a large gene family that digest various ECM components and are noted for their role in ECM remodeling during tissue growth, morphogenesis and repair. The PA are implicated in control of ECM remodeling via their ability to convert the ubiquitous zymogen plasminogen to its active form plasmin, which directly and indirectly mediates ovarian ECM degradation. The fundamental

role of the ECM in the control of growth, differentiation, and resorption of ovarian structures and the regulation of ovarian ECM remodeling by the MMP and PA will be discussed. Our results indicate that the MMP and PA are temporally and spatially regulated during specific stages of the ovarian cycle and control ECM remodeling fundamental to ovarian

function. Supported by USDA 98-35203-6226 (GWS) & 98-35203-6282 (MFS).

Key Words: Ovarian Extracellular Matrix Remodeling, Matrix Metalloproteinases, Plasminogen Activators

ADSA Dairy Foods: Cheese

602 Quality attributes of cheddar cheese in the North Carolina marketplac. A. Hansen* and M. Keziah, *North Carolina State University Raleigh, N.C. USA.*

Approximately 250 samples of cheddar cheese were obtained from various retail markets in North Carolina. Cheddar cheese samples were evaluated over a two year period. The evaluation was conducted with 15 trained dairy judges. Attributes were appearance, body and texture and they were evaluated according ADSA protocol. The major defects in appearance were open and a few samples were gassy. The major body defects were, from most to least, short, crumbly, pasty and curdy. The flavor defects from most to least were high acid, bitter, whey, sulfide, unclean, heated, flat and yeasty. The national brands of cheeses had less appearance and body defects. The main flavor defects were high acid, bitter, sulfide and whey, whereas the store brands tended to be more open and gassy in appearance. The body and texture would be short, curdy, crumbly and pasty depending on the brand. The store brands tended to have more off flavors such as unclean, oxidized, yeasty, flat, whey, sulfide, fermented and fruity. The store brands of sharp cheese tended to be acid, bitter and sulfide as compared to the national brand cheese which were acid and sulfide. The national brands usually had a cleaner flavor and were better quality

Key Words: Cheddar Cheese, Marketplace, Quality

603 Salt and calcium distribution in injected cheese. A.J. Pastorino*¹, N.P. Ricks², C.L. Hansen¹, and D.J. McMahon¹, ¹*Utah State University*, ²*Ohio State University*.

Modifying cheese attributes by injecting ionic solutions requires knowledge of the time needed to obtain uniform concentration of ions in the cheese. Therefore, our objective was to determine whether even distribution of sodium chloride (salt) and calcium chloride in cheese, over 1.0 cm distance from injection site could be obtained after 30 to 45 d. Full-fat salted cheese (25% fat, 45% moisture) and reduced-fat unsalted cheeses (22% fat, 42% moisture) were made according to direct-acid, stirred-pressed curd procedures. Cheeses were cut into 0.4 to 0.6-kg blocks, vacuum-packaged, and stored at 4°C. After 3 wk of storage, full-fat cheese blocks were high-pressure injected with a 40% calcium chloride solution, while reduced-fat blocks were injected with a 23% salt solution. Injection was performed in a single, centered row, in the top of the cheese block, with injection sites 1 cm apart. Pressure of injection was set at 1500 psi, and burst duration at 1.5 s. Cheese blocks were then vacuum-packaged and stored at 4°C. After storage, cheeses were sectioned into bands, 0.5 cm thick, parallel to the injection line. Three bands to each side of the injection line were considered for analysis, and the chloride and calcium content determined. Salt-injected cheese was analyzed 6 wk after injection and had increased salt content compared to uninjected cheese, 0.25% versus 0.16% ($P < 0.01$). Also, the injected cheese had an even distribution of salt over 1.5 cm from the injection line. Calcium-injected cheese, analyzed 4 wk after injection, had increased calcium content when compared to uninjected cheese, 0.43% versus 0.33% ($P < 0.01$), and had even distribution of calcium over 1.0 cm from the injection line. Upon injection, increased localized ion concentration generated a concentration gradient in the cheese that operated as a driving force for ions to diffuse. Also, deflection of the injectant as it enters the cheese would provide some initial dispersion of the solution. We concluded that injecting concentrated solutions of sodium and calcium chloride allows for increasing their content in the cheese, and that injecting these solutions using a 1 x 1-cm injection pattern allows for even distribution of ions in 30 d.

Key Words: Cheese, Salt, Calcium

604 Characterization of the melt properties of Cheddar cheese during ageing using dynamic low amplitude oscillatory rheology and melt profile analysis. Achyuth Hassan* and John Lucey, *University of Wisconsin-Madison.*

Melt characteristics are an important functionality of cheese on pizza. The melting properties of Cheddar cheese during ageing were determined by melt profile analysis and two dynamic low amplitude oscillation (DLAO) tests on a Physica UDS 200 rheometer. The newly developed melt profile method measures changes in cheese height during heating from 12 to 60°C and provides information on extent of flow and softening temperature. Extent of flow values (i.e., decrease in original cheese height) for 1, 7, 14, 21, 30, and 90 d samples were 54, 61, 64, 71, 71.5, and 71.5%, respectively. Rheological properties of cheese were evaluated at a strain of 0.2% and frequency of 0.1 Hz. Storage modulus (stiffness) and loss tangent parameters were determined from DLAO tests during heating. Cheeses were given two different types of heating profiles; one profile was the same as that used in the melt profile analysis technique (a non-linear but short heating profile or SHP). In the second heating profile, cheeses were heated from 5 to 80°C at constant rate of 1°C/min (long heating profile or LHP). In both heating profiles the loss tangent remained constant up to 40°C (0.5) and thereafter increased. The temperature when the loss tangent initially increased was similar to the softening temperature determined by melt profile analysis. Loss tangent values (at temperatures >40°C) increased with the age of cheese. In SHP tests, the values of the loss tangent at 55°C were 0.7, 1.3, 1.5, 1.7, 2.0, and 2.3 for 1, 7, 14, 21, 30, and 90 d cheese, respectively. In samples subjected to LHP, a well defined peak was observed in loss tangent and maximum values were 1.2, 2.0, 2.3, 2.5, and 2.1 which occurred at temperatures of 69, 67, 65, 64, 62, and 57°C for 1, 7, 14, 21, 30, and 90 d cheese, respectively. The decrease in height of cheese samples during heating paralleled trends in the increase in loss tangent value from rheological tests. An increased loss tangent indicates a change in character of cheese from solid-like material to viscous or liquid-like and it appears that this increase is involved in melting and flow of cheese at high temperatures. With increasing age and proteolysis the extent of flow increased and this coincided with higher loss tangent values in rheological tests.

Key Words: Rheology, Cheese, Melt profile

605 Reduced fat Cheddar cheese from a mixture of cream and liquid milk protein concentrate. Shakeel Rehman* and Nana Farkye, *Dairy Products Technology Center, Calpoly State University.*

Liquid milk protein concentrate (LMPC) is a high protein and low lactose dairy ingredient manufactured by ultrafiltration of skim milk. The study was undertaken to use LMPC and cream mixture in reduced fat Cheddar cheese (RFC) manufacture in order to increase yields. Control RFC was manufactured from standardized milk casein/fat, C/F 1.7, obtained from mixing whole milk (WM) and skim milk (SM) while experimental RFC was manufactured from standardized milk, C/F 2.0, obtained from mixing LMPC and 35 % fat cream. The % yield, % total solid (TS) and fat recoveries in the experimental RFC were 21.2, 61.4 and 85.4 as compared to 8.0, 45.1 and 77.3 in the control RFC, respectively. The average % moisture, fat, protein, salt and lactose were 40.7, 15.3, 32.8, 1.4 and 0.07, respectively, in the experimental cheese and 39.3, 15.4, 33.0, 1.3 and 0.10, respectively, in the control cheese. No growth of non-starter lactic acid bacteria (NSLAB) was detected in control or the experimental cheeses up to 3 mo ripening but at the end of 6 mo ripening the experimental cheese had 10^7 cfu NSLAB / g as compared to 10^6 cfu / g in the control. The experimental cheese had lower levels of water soluble N (as % of total N) than the control cheese after 6 mo ripening, suggesting lower levels of primary proteolysis in the experimental cheese. The total free amino acids, determined by Cd-ninhydrin method, were significantly lower in the experimental cheese than the control cheese during 6 mo ripening, suggesting lower

secondary proteolysis in the cheese containing LMPC. It can be concluded from the results of this study that LMPC can be used in the manufacture of RFC to improve yield, and fat and TS recovery. However, proteolysis in cheese made with LMPC and cream is slower than that made with WM and SM.

Key Words: Milk protein concentrate, reduced fat Cheddar

606 Effects of standardization of whole milk with milk protein concentrate on the yield and ripening of reduced fat Cheddar cheese. Shakeel Rehman¹, Nana Farkye¹, and Andrew Schaffner², ¹Dairy Products technology Center, Calpoly State University, San Luis Obispo, CA, ²Department of Statistics.

Milk Protein concentrate (MPC), manufactured by spray drying of skim milk retentate, is becoming a popular dairy ingredient. Because of its high protein and low lactose contents, MPC can be used to standardize whole milk to give high yields of reduced fat Cheddar cheese. Four cheesemaking trials were conducted, each involving three cheeses, one control (CC) made from standardized milk (casein to fat ratio, C/F 1.7) obtained by mixing skim milk and whole milk (WM); the other two (MP1 and MP2) made from standardized milk (C/F 1.8) obtained from mixing WM and MPC. Commercial mesophilic starter was added at the rate of 1% to the CC and MP1, and 2% to MP2. The addition of MPC doubled the yield and resulted in significant increases in the recovery of fat (94% in MP1 and MP2 vs 92% in CC) and total solids (43% in CC vs 63% in MP1 and MP2). Although minor differences were noted in the gross composition of the cheeses, both MP1 and MP2 cheeses had lower lactose, 0.25 or 0.32, respectively in MP1 or MP2 than in CC (0.60%). All the three cheeses had 10⁹ cfu/g starter bacteria. The non-starter lactic acid bacteria (NSLAB) grew slowly in MP1 and MP2 cheeses during ripening compared to CC, and at the end of 6 mo, the CC had 1-2 log cycle NSLAB higher than MP1 and MP2. Primary proteolysis, as noted by urea-PAGE or water soluble N contents, was markedly slower in MP1 and MP2 compared to CC. The concentration of total free amino acids, as determined by Cd-ninhydrin method, was highest in the CC cheese followed by MP2 and MP1, respectively, suggesting slower secondary proteolysis in the MPC than in CC cheese. Increasing the amount of starter bacteria improved secondary proteolysis in MPC cheese.

Key Words: Milk protein concentrate, reduced fat Cheddar

607 Controlling the coagulation properties of high solids cheesemilks that are standardized with cold ultrafiltration retentates. S. Govindasamy-Lucey^{*1}, J.J. Jaeggi¹, M.E. Johnson¹, and J.A. Lucey², ¹Wisconsin Center for Dairy Research, University of Wisconsin, Madison, Wisconsin/USA, ²Department of Food Science, University of Wisconsin, Madison, Wisconsin/USA.

The cheese industry is currently using higher solids milks with the objective of increasing yields and processing efficiency. Increasing the solid contents of milk in-vat from 11 to 14.5% results in faster coagulation and firmer setting of the curd but possibly increased fat losses in whey if the cutting process is not carefully controlled. In this study, the coagulation properties of cheesemilks were determined using dynamic low amplitude oscillation in a Physica UDS 200 Rheometer. Milks with elevated solids (14.5%) were made by blending retentates obtained by cold (<7C) UF. Control milks with similar casein:fat ratios and total solids of 11.3% were also analyzed. The effects of cutting on the textural properties of rennet-induced gels were simulated using a low constant shear (0.01 s⁻¹) test of the pre-formed gel made in the rheometer. The shear test was performed at the cutting times that our licensed cheesemakers used in cheese trials with these types of milk. Several trials were performed with gels made in the rheometer under identical conditions (pH, temperature, enzyme concentration) as used in Parmesan and Swiss cheese manufacture. Gels made from higher solids cheesemilks coagulated faster (although the rennet to casein ratio was identical for all samples), with a reduction in clotting time by 25-30%. The shear stress of the gels, that is, the force required to break the gels, during shearing was considerably higher (120-130%) in the high solids cheesemilks compared to control samples, which indicates that the cutting operation may need to be modified to prevent excessive fat losses. The storage modulus (or stiffness) of all gels at cutting were generally similar as our cheesemakers started cutting the coagulum earlier in the higher solids milks. The rate of firming was considerably faster in the higher solids milks. In commercial cheese vats, it is more difficult to monitor coagulation and the cutting cycle is considerably longer than in our pilot-scale

cheesemaking; both problems need to be addressed so as to successfully use higher solids cheesemilk with conventional cheesemaking equipment.

Key Words: Coagulation, Rheology, Ultrafiltration

608 Study of the effects of pH, temperature and NaCl on amino acid catabolic enzyme activities using quadratic response surface methodology. A.C. Curtin¹, M. De Angelis², M. Cipriani², M.R. Corbo³, P.L.H. McSweeney^{*1}, and M. Gobbetti⁴, ¹University College, Cork, Ireland, ²University of Perugia, Italy, ³University of Foggia, Italy, ⁴University of Bari, Italy.

The objectives of this study were to screen cystathionine- β -lyase, cystathionine- γ -lyase and L-methionine aminotransferase activities of lactococci, lactobacilli and coryneform bacteria and to determine the individual and interactive effects of temperature, pH and NaCl concentration on these enzyme activities which may have a role in flavour development during cheese ripening. A subcellular fractionation protocol and specific enzyme assays were used, and a quadratic response surface methodology was applied. The majority of the strains (21 of 33) had detectable cystathionine lyase activity the level of which varied between strains. L-Methionine aminotransferase activity was observed in only 3 strains. The cystathionine lyase activities of *Lactobacillus reuteri* DSM20016, *Lactococcus lactis* subsp. *cremoris* MG1363, *Brevibacterium linens* 10 and *Corynebacterium ammoniagenes* 8 and the L-methionine aminotransferase activity of *Lb. reuteri* DSM20016 had temperature and pH optima of 30-45C, and 7.5-8.0, respectively. As shown by quadratic response surface methodology, these enzymes retained activities in the range of temperature, pH and NaCl concentration characteristic of the cheeses from which the bacteria originated. The results of this study contribute to knowledge about the role of amino acid catabolic enzymes in flavour development in cheese during ripening.

Key Words: Amino Acid Catabolism, Cheese Flavour

609 Headspace analysis of volatile compounds in Monterey Jack goat milk cheese. R. Attaie^{*1}, Prairie View A&M University, Prairie View, TX.

Samples of goat Monterey Jack cheese were used for analyses of volatile compounds on day 1 and at 6 week intervals for 30 weeks during aging. These cheeses were vacuum-packed and stored at 4 to 5C for sampling and aging. Triplicate 0.5 g samples of cheese were placed in 20 ml vials of headspace analyzer (HS 40XL, Perkin Elmer, Norwalk, CT) and heated at 120 C for 60 min while rotating. The needle temperature was kept at 120 C and the transfer line was set at 150 C. Samples were pressurized for 0.5 min prior to injection and the injection time was 0.1 min. Analyses were performed using a bonded polyethylene glycol fused silica capillary column (Supelcowax-10, 60 m x 0.32 mm i.d., 0.25-m coating thickness; Supelco Inc., Bellefonte, PA). Gas chromatography was performed with a model HP 5890 Series II (Hewlett-Packard, Avondale, PA) equipped with a flame ionization detector. Ultra-high purity helium at 1.5 ml/min and 30 ml/min was used as carrier and makeup gas, respectively. Ultra-high purity hydrogen (30 ml/min) and high purity air (400 ml/min) were used for flame ionization detector. Detector temperature was at 250 C, whereas the column oven temperature was increased from 40 to 220 C at 3 C/min after an initial hold at 40 C for 2 min. The peak areas of compounds from gas chromatographic responses were measured quantitatively by a model HP 3396 Series II integrator (Hewlett-Packard). Both the integrator attenuation and threshold were set at 2. The following volatile compounds that contribute to flavor of goat Monterey Jack cheese were identified: propionaldehyde, butanal, methanol, ethanol, pentanal, 2,3-butanedione, propanol, 2-hexanone, 3-ethyl-2-pentanone, butanol, 2-heptanone, pentanol, 3-methyl-2-pentanol, 3-hydroxy-2-butanone, hydroxy acetone, 2-nonanone, acetic acid, 2-decanone, 2,3-butanediol, butanoic acid, 2-methyl butanoic acid, pentanoic acid, hexanoic acid, heptanoic acid, octanoic acid, and nonanoic acid.

Key Words: Goat cheese, Flavoring compounds, Ripening

610 Effect of microbial exopolysaccharide on functionality in high moisture cheese. T. J. Singleton^{*1}, D. J. McMahon¹, J. R. Broadbent¹, and C. J. Oberg², ¹Western Dairy Center, Utah State University, ²Weber State University.

Functional attributes of cheese such as shreddability and melt are dramatically affected by cheese moisture level. Previous work by our group has demonstrated that the addition of *Streptococcus thermophilus* MR1C, a strain that produces a large capsular exopolysaccharide (EPS⁺), to cheese results in a significant increase in the cheese moisture level. The objectives of this study were to determine if the addition of MR1C could be used to improve shreddability in high moisture American style cheese. Stirred curd cheeses were manufactured to contain equivalent moisture levels using either MR1C (41.4 - 43.7% moisture) or a non EPS-producing (EPS⁻) derivative of MR1C (40.5 - 44.4% moisture). The suitability of individual cheeses for shredding was determined by rheometry and texture profile analysis. Cheese firmness was determined after 1, 3, and 6 weeks of aging, then the cheese was shredded, and 3% (wt/wt) powdered cellulose was added to prevent caking. The cheese was packaged with a nitrogen gas flush, and melt properties were measured periodically. When cheeses with the same moisture content (i.e., 41.6 ± 0.2%) were compared over the 6 wks of storage, there was no overall significant affect on hardness although there was a significant week * culture interaction ($P = 0.026$). The (EPS⁺) cheese was softer at wk 1, then became harder at wk 3, but softened by wk 6. There was also a tendency ($P = 0.095$) for the (EPS⁺) cheese to be less adhesive than the (EPS⁻) cheese. There were no overall differences in elasticity or viscosity, and the cheeses melted to the same extent after 6 wks storage from when the cheese was shredded.

Key Words: Exopolysaccharide, Functionality, American style

611 Relationship between chemical, physical and sensory properties for pasta filata and stirred curd LMPS Mozzarella cheeses. C. M. Chen^{*}, A. L. Dikkeboom, M. E. Johnson, and M. G. Zimbric, Wisconsin Center for Dairy Research.

Chemical (pH, TCA sol N) and physical properties (free oil release, melt profile) of LMPS Mozzarella (46.4.9% moisture, 42.8.9% FDM) were correlated to sensory characteristics. Descriptive taste panelists scored the degree of skinning (none to pronounced), chewiness (tough/chewy to tender/fluid), and preference (dislike to like) of cheese on pizza pies cooked in traditional and forced air ovens. Stirred curd Mozzarella tended to exhibit more skinning than pasta filata Mozzarella. In a traditional oven the degree of skinning remained constant (very slight, all ages). In a forced air oven, cheeses had an increased skinning after 10 d (slight to definite). For the stirred curd Mozzarella in a forced air oven there was a high correlation between the skinning and softening temperature (negative, $R^2 = .95$) and proteolysis (positive, $R^2 = .89$). Cheese chewiness was influenced by the age, manufacturing protocol, and to a lesser extent, oven type. Stirred curd Mozzarella was more fluid/tender than the pasta filata Mozzarella, and cheeses baked in a forced air oven tended to be more chewy. For stirred curd Mozzarella, softening temperature in the melt profile most highly correlated with

the chewiness scores ($R^2 = .88$). For pasta filata Mozzarella, chewiness was most highly correlated to free oil release ($R^2 = .85$). Preference was influenced by the cheese age, but not manufacturing style or oven type. Cheeses were most preferred at 10 d, with stirred curd Mozzarella being slightly more liked than the pasta filata Mozzarella. The high preference scores can be attributed to lack of skinning, slightly tender/fluid chew characteristics and more acceptable strand formation. Using the linear relationship between chewiness scores and softening temperature, one can predict that if a stirred curd LMPS Mozzarella cheeses softens between 40.5 and 43.3C it will have acceptable performance on pizza pies. Similarly, pasta filata LMPS Mozzarella with free oil release between 43 and 48% (wt free oil release/wt cheese fat) will have acceptable performance on pizza pies.

Key Words: Mozzarella, physical properties, sensory analysis

612 Reversibility of pH-induced changes in the melting characteristics and calcium distribution of Mozzarella cheese. Q. Ge, M. Almena-Aliste, and P.S. Kindstedt^{*}, University of Vermont, Burlington, VT/USA.

Previously a model system was developed to increase or decrease the pH of Mozzarella cheese through exposure to volatile ammonia or acetic acid, respectively. Changing the cheese pH in this manner caused large changes in the apparent viscosity and calcium distribution. The objective of this study was to evaluate whether these pH-induced changes are reversible. In the first experiment, representative samples of shredded low moisture part-skim Mozzarella cheese were exposed to ammonia to increase the pH by ca. 1.0 pH unit in 3 increments. After equilibration at 4°C for 24 h, the samples were analyzed for apparent viscosity and water soluble calcium. Next, the sample with the highest pH value was divided into representative subsamples and then exposed to acetic acid vapor to decrease the pH by ca. 1.0 pH unit (i.e., to the original cheese pH) in 3 increments. After equilibration at 4°C for 24 h, the subsamples were analyzed for apparent viscosity and water soluble calcium. This experiment was replicated 3 times with different batches of cheese. The second experiment was similar to the first except that the cheese pH was first decreased in 3 increments to ca. pH 4.7 and then increased. In the first experiment, increasing the cheese pH from ca. 5.3 to 6.3 resulted in linear increases in apparent viscosity and linear decreases in water soluble calcium. Upon reversal of cheese pH back to ca. 5.3, apparent viscosity decreased and water soluble calcium increased in linear manners, displaying high degrees of reversibility. In the second experiment, decreasing the cheese pH from ca. 5.3 to 4.7 resulted in nonlinear increases in apparent viscosity and water soluble calcium. Upon reversal of cheese pH back to ca. 5.3, apparent viscosity and water soluble calcium decreased in nonlinear manners, displaying high degrees of reversibility. Results indicate that the melting characteristics of Mozzarella cheese can be altered substantially and then restored by manipulating cheese pH and shifting calcium between the water soluble and casein-associated states.

Key Words: Mozzarella, Functionality, Calcium

ASAS Nonruminant Nutrition: Weaning Pig Nutrient Requirements

613 Effect of threonine supply on the true ileal digestibility of amino acids and on performance in weaned piglets†. L. Babinszky^{*}, J. Tossenberger, P. Horn, and R. Kovcs, University of Kaposvar, Kaposvar, Hungary.

Weaned piglets were used in a trial aimed at determining the effect of threonine supply on true ileal digestibility of amino acids and piglet performance. Digestibility studies used a total of 8 animals per treatment, growth studies a total of 96 piglets per treatment, respectively. Initial live weight was 12.4±1.8 kg in the digestibility studies, and 7.8±1.0 kg in the growth study. Nutrient content of the wheat-barley-soybean based diets of different threonine levels complied with the NRC (1998) recommendations. One kg of the basal diet contained 13.4 MJ ME, 188 g CP, 12.2 g Lys, 8.5 g M+C and 6.2 g Thr. Endogenous amino acid excretion was determined in a separate trial group (n=8) by feeding N-free diets. In the digestibility studies we used three treatments (0, 1.3 and 2.1 g crystalline Thr per 1 kg feed), and six treatments in the growth studies (0, 0.42, 0.84, 1.26, 1.67, 2.09 g crystalline Thr per 1 kg feed). The diet chemical composition was determined in accordance with

AOAC. Trial data were subjected to variance and regression analyses. Our results show that 586 mg/kg DM intake threonine was excreted in the endogenous protein. From non-essential amino acids, excretion rate of proline was highest (2321 mg/kg DM intake). The varying threonine supply did not affect the true digestibility of amino acids ($P \geq 0.05$), the digestibility of threonine, however, was improved significantly ($P \leq 0.05$). Based the regression analysis and performance studies data the true ileal digestible threonine content for weaned piglets (8 to 30 kg) can be recommended at 6.6 g per kg of diet, which corresponds to a true ileal digestible threonine to lysine ratio of 62:100.

†Trials were supported by DEGUSSA-HLS AG/Germany

Key Words: Threonine, Piglets, Digestibility

614 The optimum threonine:lysine ratio in nursery diets to maximize growth performance of weanling pigs. B. W. James*, R. D. Goodband, M. D. Tokach, J. L. Nelssen, J. M. DeRouchey, and J. C. Woodworth, *Kansas State University, Manhattan.*

The objective of this 21-d growth assay was to determine the optimal apparent digestible threonine:lysine ratio in nursery pig diets to maximize growth performance. A total of 210 pigs (initially 8.2 kg and approximately 25 d of age, PIC C22 × 327) were blocked by weight and allotted randomly to seven dietary treatments. Each treatment had six replicates and five pigs per pen. Corn, soybean meal, and spray-dried whey were analyzed for amino acid concentrations prior to diet formulation. Crystalline L-threonine was added to the basal diet (14.1% CP; 1.07% apparent digestible lysine) to provide 0.48, 0.54, 0.59, 0.64, 0.70, and 0.75% apparent digestible threonine (45, 50, 55, 60, 65 and 70% of lysine). A negative control diet (Neg) contained less L-lysine-HCl and provided 0.97% apparent digestible lysine and 0.75% apparent digestible threonine to ensure that lysine did not exceed the pigs' requirement. During the 21-d experimental period, ADG increased (linear, $P < 0.02$) as the ratio of apparent digestible threonine:lysine increased and was maximized for pigs fed 65% apparent digestible threonine:lysine. Feed intake tended to decrease (quadratic, $P < 0.09$) with increasing concentrations of apparent digestible threonine. Feed efficiency (G:F) improved (linear, $P < 0.01$) as the ratio of apparent digestible threonine:lysine increased and was maximized at 55% threonine to lysine. Plasma urea N measured on d 14 tended to decrease (linear, $P < 0.08$) with increasing apparent digestible threonine. The two-slope broken-line method predicted an approximate apparent digestible threonine requirement of 65 and 52% of apparent digestible lysine for ADG and G:F, respectively.

Item	% Threonine:Lysine						Neg
	45	50	55	60	65	70	
Days 0 to 21							
ADG, g	442	447	460	448	485	447	479
ADFI, g	804	762	758	732	815	787	829
G:F	0.55	0.59	0.61	0.61	0.60	0.61	0.58

Key Words: Threonine, Lysine, Weanling pigs

615 Effects of diet and crystalline glutamine supplementation on growth performance and small intestine morphology of weanling pigs. S. J. Kitt*, P. S. Miller, A. J. Lewis, and R. L. Fischer, *University of Nebraska, Lincoln.*

The objective of this experiment was to determine whether crystalline glutamine affects weanling pig growth and/or small intestine morphology. A total of 115, 18 (± 2)-d-old, mixed-sex pigs were used in this study. Four pigs were killed on d 0 to determine base-line intestine morphology. The remaining pigs were blocked by initial BW (6.1 \pm 1.1 kg) and randomly allotted to 16 pens and one of four dietary treatments in a 2 × 2 factorial arrangement. Treatments were two diet types (simple or complex) and two supplemental concentrations of crystalline glutamine (0 or 1%). The simple diet consisted primarily of corn and soybean meal. The complex diet consisted primarily of whey, corn, soybean meal, spray-dried plasma, and fish meal. All diets (total dietary lysine = 1.60%) were formulated to exceed all nutrient requirements (NRC, 1998). Average daily gain and ADFI were measured on d 4, 7, 14, and 21. Four pigs from each treatment were killed and duodenal and jejunal samples were collected on d 4. Intestine samples were fixed in 10% formalin and stored in 70% ethanol. Tissues samples were mounted on slides and villus height was analyzed using a commercially available software program. The complex diet improved ($P \leq 0.10$) ADG of pigs during d 0 to 4, 7 to 14, and 14 to 21. The complex diet increased ($P \leq 0.05$) ADFI during d 0 to 4, 4 to 7, 7 to 14, and 14 to 21. The simple diet increased ($P \leq 0.05$) ADG/ADFI during d 7 to 14, and 14 to 21. The addition of glutamine increased ($P \leq 0.05$) ADG/ADFI during d 14 to 21. Villus height was not affected ($P \geq 0.10$) by diet type or glutamine supplementation during d 0 to 4. These data suggest that glutamine improves growth performance in weanling pigs but does not affect villus height during the first four days after weaning.

Key Words: Glutamine, Small intestine morphology, Pigs

616 Responses of pigs and chicks to phosphorus supplementation in casein- vs soybean meal-based diets. E. G. Xavier*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington.*

Previously, we have assessed the bioavailability of P in feedstuffs using a dextrose-dehulled soybean meal (SBM) diet (0.22% total P, 0.15% phytate P) with P sources substituted for dextrose. In some instances, it would be desirable to utilize a low-P basal diet containing no phytate P. This study was conducted to assess the suitability of semipurified diets with casein vs SBM as the protein source without and with added P (as monocalcium phosphate) for young pigs and chicks. In Exp. 1, 20 pigs (4 reps, 10.8 kg BW) were fed 5 diets (1.2% lys, 0.8% Ca) for 35 d: sucrose-dextrose (SD)-casein (15%) with 0, 0.1, and 0.2% added P or SD-SBM (40%) with 0.04 and 0.24% added P. The bioavailable P in both basal diets was 0.11%. AA (lys, thr, trp, met, arg) were added as needed. ADG, feed/gain, and breaking strength of the femurs and metatarsals were: 461, 520, 644, 470, 652 g; 2.04, 1.98, 1.89, 1.91, 1.74; 45, 80, 169, 48, 147 kg; 14.9, 22.7, 38.9, 19.6, 39.8 kg. Performance and bone traits of pigs fed the two basal diets were similar as were the linear ($P < 0.01$) responses to added P in both diets. A 14-d study was conducted with 3-d-old chicks fed casein or SBM-based diets. Chicks (4 reps of 6 chicks/pen) were fed: dextrose-starch (DS)-casein (20%) with 0.10, 0.15, 0.20, 0.25, 0.30, and 0.35% added P or DS-SBM (40%) with 0.16, 0.26, and 0.36% added P. Ca was 1.0% in all diets. The two basal diets contained 0.25 and 0.43% total P, and 0.25% non-phytate P. AA were added as needed. ADG and tibia strength were: 20.6, 23.0, 25.1, 24.4, 23.8, 25.7, 19.6, 28.5, 33.7 g; 4.6, 7.4, 9.9, 10.9, 9.7, 11.2, 2.8, 7.8, 13.9 kg. Performance was similar for chicks fed the two basal diets. Growth and bone responses to added P were linear ($P < 0.01$) for both diet types; however, responses were greater for the SBM vs casein diet, primarily due to greater feed intake (43 vs 35 g/d), thus greater P intake, of chicks fed the high-P, SBM diet. The results indicate that casein-based diets containing no phytate P should be acceptable for future P bioavailability studies with pigs and chicks.

Key Words: Pigs, Chicks, Phosphorus

617 Ideal dietary tryptophan regimen for pigs as influenced by antigen exposure. C. P. Machado*¹, T. S. Stahly¹, and T. J. Stabel², ¹Iowa State University, Ames, ²National Animal Disease Center, Ames, IA.

Pigs from a high lean strain were reared via a SEW procedure and self-fed a basal diet containing 100% of ideal ratio (IR; NRC, 1998) of digestible tryptophan (Trp) to digestible lysine (Lys). At 30 d of age, pigs were allotted within litter to one of four dietary ratios of Trp:Lys: 50, 75, 100 or 125% (day 0). The basal diet consisted of a corn-SBM-gelatin mixture containing a growth limiting amount of digestible Lys (0.95%) and all other essential amino acids, except Trp, at ratios greater than 100% of IR. Tryptophan was added as L-Tryptophan at the expense of cornstarch. Half of the pigs were administered subcutaneously a non-replicating antigen, autoclaved BCG (13 × 10⁶ CFU/mg), at a dose of 0.20 mg/kg BW on d 4, 8 and 12. BCG induces IFN-gamma synthesis and thus indoleamine 2-3 dioxygenase release, which degrades tryptophan in several body tissues. BW gain, gain:feed ratio (GF) and body nitrogen accretion (NA) were determined for three consecutive four-day periods (d 4-16). As dietary Trp:Lys ratios increased, daily BW gain (79, 280, 518, 528 g), GF (.26, .52, .71, .68) and daily NA (3.6, 8.7, 13.9, 14.3 g) increased quadratically ($P < .01$) independent of BCG and period. BCG depressed ($P < .05$) BW gain (316 vs. 386 g), GF (0.51 vs. 0.57) and NA (9.2 vs. 11.1 g) with the magnitude of the depression increasing from d 8 through 16. In conclusion, the IR of Trp:Lys (NRC, 1998) was not altered by exposure to autoclaved BCG, a non-replicating antigen.

Key Words: Pigs, Tryptophan, BCG

618 Pyridoxine (B6) metabolism and requirement in weaned piglets. J. J. Matte*, A. Giguere, and C. L. Girard, *Dairy and Swine R & D Centre, AAC, Lennoxville, QC, Canada.*

Three trials were carried out in order to determine the effects of dietary B6 and its interactions with riboflavin (B2) on metabolic criteria such as blood B6 and B2 status, insulinemic responses to *i.v* and gastric glucose, and on growth performance of piglets weaned at 2 wks of age. In

Trial 1, 36 piglets fed through a permanent gastric tube received 4 combinations of B6 and B2 supplements (ppm), 0-0, 0-25, 50-0 and 50-25. There was a marked effect ($P \leq .01$) of the B6 supplement on B6 in red blood cells (RBC) but no effect ($P \geq .20$) of B2 on B2 metabolites (riboflavin, FMN and FAD) in plasma. C-peptide and insulin responses to *i.v.* glucose decreased ($P \leq .08$ and $.03$, respectively) with B2. This B2 effect disappeared in presence of B6 after gastric glucose (interaction $B6 \times B2$, $P \leq .02$); the response was maximized with both vitamins. It seems that B6 acts via the entero-insular axis of insulin secretion. No treatment effect ($P \geq .30$) was observed on growth rate. In trial 2, treatments used in trial 1 were given to 544 piglets in commercial conditions. No effect ($P \geq .39$) of either B6 and/or B2 supplements, given during the 2 wks after weaning, was observed on growth performance between 2 (weaning) and 10 wks of age. However, the B6 profile in RBC suggested that the lack of effect on growth performance could be due to the short duration of the B6 supplementation. Another trial, under similar conditions to Trial 2, was therefore undertaken to measure the effect of the B6 supplement alone (50 ppm) given between 2 (weaning) and 10 weeks of age. Despite a marked and persistent increase ($P \leq .01$) of B6 in RBC, the effect on growth performance was marginal and even slightly (less than 2 %) detrimental ($P \leq .03$). In conclusion, although a dietary supplement of 50 ppm of B6 was necessary to saturate the RBC pool in B6, the basal provision of dietary B6 (analytical level of 7.6 ppm) in the present diets, already 5 times higher than the NRC (1998) recommendation, appears sufficient for growth performance during the post-weaning period in piglets.

Key Words: Early-weaned piglets, Pyridoxine, Riboflavin

619 Effect of desiccated bile salts on fat digestibility in early-weaned pigs. J. Orban*¹ and B Harmon², ¹*Southern University*, ²*Purdue University*.

Thirty-six early-weaned pigs averaging 13 to 14 days of age were fed diets containing 7% hog fat and desiccated hog bile at 0, 0.15, 0.30, and 0.45 % in a metabolism study to determine the response of the pigs to fat digestibility and nutrient metabolism. The study was conducted in two trials. In Trial 1, a total of 24 barrows were used, placing 2 barrows per pen in a metabolism room with 12 metabolism crate-pens. Dietary treatments were replicated 3 times among pens and pigs in a pen constituted an experimental unit. Trial 2 was conducted similarly to Trial 1, except 12 barrows were used with one barrow per pen. In both trials, pigs were acclimated for 6 days and fasted 24 h prior to providing diets at the rate of 5% of the pigs' body weight. Fecal samples were collected in a 5 to 6-d period for digestibility assay. Results showed that the inclusion of desiccated hog bile in diets of early weaned pigs resulted in a significant ($P < 0.01$) linear increase in fat digestibility (from 93 to 97%) with respect to bile level (from 0 to 0.45%) in the diet. General animal performance (feed intake, weight gain and feed efficiency) was not affected by the presence of bile in the diet. The digestibility of dry matter, nitrogen and gross energy also was not affected by the presence of bile in the diets of early-weaned pigs. Results suggest that the inclusion of desiccated hog bile in the diets of early-weaned pigs improved their ability to digest dietary fat with no adverse effect on general performance and nutrient metabolism.

Key Words: Desiccated hog bile, Fat digestibility, Early-weaned pigs

620 The efficacy of zinc methionine and zinc oxide in promoting nursery pig performance. G. A. Hollis*, D. C. Mahan, S. D. Carter, T. D. Crenshaw, G. L. Cromwell, G. M. Hill, A. J. Lewis, and T. L. Veum, *NCR-42 Swine Nutrition Committee*.

Previous research has suggested that organic Zn sources could be added to pig nursery diets at dietary levels below the pharmacological levels of ZnO commonly used in pig starter diets and still produce similar growth promotion benefits. A regional study was therefore conducted using five treatments to compare the efficacy of supplemental Zn methionine at levels of 125, 250, and 500 ppm Zn, 2,500 ppm Zn from ZnO, and a basal diet that contained a conventional Zn level. A total of 616 pigs was used in a randomized complete block design conducted at seven university research stations in 26 replicates. Pigs were weaned at an average of 21 d of age and 6.3 kg BW, and housed with 4 to 6 pigs/pen (pig number per pen was constant within replicate). Diets fed during d 0 to 14 and 15 to 28 d were formulated to contain 1.40% and 1.25% lysine (total) levels, respectively. Diet analyses demonstrated that the basal diets averaged 124 ppm Zn. Analyzed Zn contents of treatment

diets were close to calculated values when the amount in the basal diet was added to the supplemental level. During the initial 7-d period, there were no treatment differences ($P > 0.15$) in daily gains or feed intakes. Both sources of Zn improved performance responses after 7-d postweaning when compared to pigs fed the basal diet. From 7 to 14 d, 0 to 14 d, 14 to 28 d, and for the overall 28-d period, pigs fed the ZnO source had higher gains ($P < 0.05$) than pigs fed Zn methionine. Feed intakes were unaffected by treatment during the initial 14 d postweaning, but from d 14 to 28 and for the 0 to 28-d period feed intake was higher when ZnO was fed ($P < 0.05$). Overall ADG, ADFI, and G/F ratio for the basal, three levels of Zn methionine, and ZnO treatments were: 371, 391, 389, 396, 415 g/d; 586, 618, 607, 617, 642 g/d; 0.633, 0.633, 0.641, 0.642, 0.642, respectively. These results demonstrated that lower dietary levels of Zn methionine did not achieve the improved performance responses as did 2,500 ppm Zn from ZnO when fed to weaned pigs.

Key Words: Zinc, Weaning, Pigs

621 Effects of iron administration on complete blood counts of nursing pigs. S.D. Carter, S.L. Mandali, and J.S. Park*, *Oklahoma State University, Stillwater*.

Two experiments were conducted to determine the effect of iron administration on body weight and complete blood counts (white blood cells, WBC; red blood cells, RBC; hemoglobin, HGB; hematocrit, HCT; mean cell hemoglobin (MCH) and concentration, MCHC; and platelets, PLT) of nursing pigs. In Exp. 1, 12 pigs from 6 litters (2 pigs/litter) were allotted randomly by BW on the day of birth (d 0) to either a saline or 150-mg injection of Fe as iron dextran. Pigs were bled on d 0, 1, 2, 4, 8, 12, 16 and at weaning. In Exp. 2, 18 pigs from 9 litters (2 pigs/litter) were allotted as in Exp. 1 and bled on d 0, 2, 4, 8, 10, 12, 16, and at weaning. Whole blood samples were analyzed within 2 hr of collection. Injections of saline or Fe were administered on d 2 following blood collections. Average weaning age was 20.5 d in each experiment. Initial (d 0) BW and HGB, averaged across experiments, were 1.60 kg and 9.52 g/dL, respectively. There were no differences ($P > 0.10$) in BW or blood variables on d 0, 2, or 4. Body wt tended to increase at a faster rate in pigs given Fe vs saline-treated pigs from d 4 to weaning (Day x Trt, $P < 0.10$). However, pigs injected with Fe tended to be heavier ($P < 0.12$) only at weaning. HGB, HCT, MCH, and MCHC in saline-treated pigs declined with age, but they increased with age in pigs given Fe (Day x Trt, $P < 0.01$). This divergence occurred by d 4 (Exp. 2) or d 8 (Exp. 1), and pigs given Fe had greater values ($P < 0.01$) each day following d 4. Blood HGB in saline-treated pigs fell below 7 mg/dL by d 8 and 6 mg/dL by d 12 in each experiment. WBC and RBC were reduced ($P < 0.10$) from d 8 to weaning in saline- vs Fe-treated pigs; however, PLT were markedly increased ($P < 0.04$). Even though pigs treated with saline were severely anemic, survival to weaning was 100%. Body weight was not correlated ($P > 0.10$) with any of the blood counts. These results suggest that Fe administration has profound effects on blood counts, in addition to HGB and HCT. However, in these pigs weaned at less than 21 d of age, iron deficiency had minimal impact on performance or survival to weaning.

Key Words: Pigs, Iron, Hemoglobin

622 Effects of L-carnitine and soybean oil on growth performance in weanling pigs. M. J. Rincker*¹, S. D. Carter¹, R. W. Fent¹, B. W. Senne¹, and K. Q. Owen², ¹*Oklahoma State University, Stillwater*, ²*Lonza, Inc., Fairlawn, NJ*.

Two-hundred sixteen weanling pigs were used in a 2 x 2 factorial arrangement of treatments in two separate experiments to evaluate the effects of L-carnitine (0 vs 50 ppm) and soybean oil (SBO; 0 vs 5%) on growth performance. In Exp. 1, 96 weanling pigs (6.0 kg; 18 d) were randomly allotted based on BW, sex, and litter to four dietary treatments (6 pens/trt of 4 pigs/pen). In Exp. 2, 120 pigs (5.6 kg; 18 d) were randomly allotted to the same treatments as in Exp. 1 (6 pens/trt of 5 pigs/pen). The four dietary treatments were: 1) 0% SBO and 0 ppm L-carnitine; 2) 0% SBO and 50 ppm L-carnitine; 3) 5% SBO and 0 ppm L-carnitine; and 4) 5% SBO and 50 ppm L-carnitine. Pigs were fed in three dietary phases (P1: d 0-10; P2: d 11-24; and P3: d 25-38 with 1.6, 1.4, and 1.2% Lys, respectively). Phase 1 and 2 diets were complex corn-soybean meal-dried whey based containing additional protein sources, while diets for P3 were corn-soybean meal based. Pigs and feeders were weighed weekly for the determination of ADG, ADFI,

and G:F. There were no treatment by experiment interactions; therefore, data were pooled across experiments (12 pens/trt). ADG, ADFI, and G:F for the 38-d study were: 394, 398, 370, and 391 g; 566, 567, 536, and 540 g; and .696, .703, .690, and .725, respectively. Pigs fed SBO tended ($P < 0.10$) to grow slower and consume less feed compared to those not fed SBO, but G:F was not affected ($P > 0.10$). The addition of L-carnitine did not affect ($P > 0.10$) ADG or ADFI; however, it did improve ($P < 0.01$) G:F. Also, the increase in G:F associated with L-carnitine was more pronounced in pigs fed SBO than those not fed SBO (carnitine \times SBO, $P < 0.08$). The greatest response to L-carnitine occurred in P2 with an increase in ADG ($P < 0.05$) and G:F ($P < 0.01$). In contrast, the response (G:F) to SBO was greatest during P3. These results suggest that the addition of 50 ppm L-carnitine improved growth performance in weanling pigs; however, supplemental L-carnitine was more effective when SBO was provided in the diet.

Key Words: Carnitine, Fat, Weanling pigs

623 Effects of L-carnitine on carcass composition and tissue accretion in weanling pigs. M. J. Rincker^{*1}, S. D. Carter¹, R. W. Fent¹, B. W. Senne¹, and K. Q. Owen, ¹Oklahoma State University, Stillwater, ²Lonza, Inc., Fairlawn, NJ.

We have previously reported that supplementing L-carnitine to the diet of weanling pigs improved growth performance and nutrient digestibility. Additionally, the effects of L-carnitine on carcass composition and tissue accretion rates in weanling pigs were evaluated. Six sets of four

littermate barrows (4.9 kg; 18 d) were housed individually and randomly allotted to four dietary treatments containing 0, 25, 50, or 100 ppm L-carnitine. Pigs were fed in three dietary phases (P1: d 0-10; P2: d 11-24; and P3: d 25-38 with 1.6, 1.4, and 1.2% Lys, respectively). Phase 1 and 2 diets were complex corn-soybean meal-dried whey based containing additional protein sources, while diets for P3 were corn-soybean meal based. All diets contained 5% soybean oil. At the conclusion of the experiment, each pig was killed and ground for determination of carcass composition. In addition, a fifth littermate from each set of pigs was killed at the beginning of the experiment for initial body composition. Percentages of protein and fat in the carcass were, respectively: 13.42, 14.01, 13.99, and 14.07; and 8.35, 7.42, 7.17, and 6.89. Increasing L-carnitine increased (linear, $P < 0.01$) the percentage of protein and decreased (linear, $P < 0.01$) the percentage of fat. Accretion rates for protein, fat, and energy were, respectively: 33, 42, 48, and 45 g/d; 21, 21, 24, and 21 g/d; and 379, 425, 483, and 426 kcal/d. A quadratic increase ($P < 0.05$) in total (g) and rate (g/d) of protein and energy accretion was observed with increasing L-carnitine. Also, the ratio of protein accretion to fat accretion (1.59, 2.07, 2.08, and 2.23) improved (linear, $P < 0.01$) with added L-carnitine. In general, the response to L-carnitine tended to plateau at 50 ppm. These results suggest that supplementation of L-carnitine improved the rate of protein and energy accretion in weanling pigs. Furthermore, an improvement in carcass composition was observed as the ratio of protein to fat accretion increased with L-carnitine addition.

Key Words: Carnitine, Weanling pigs, Accretion

ASAS/ADSA Animal Health: Dairy

624 Prevalence of bovine mastitis increases with average linear score and has possible implications for genetic selection. David Wilson^{*1}, Ruben Gonzalez¹, George Shook², Linda Garrison-Tikofsky¹, and Ynte Schukken¹, ¹Cornell University, Ithaca, NY, USA, ²University of Wisconsin, Madison, WI, USA.

Bovine genetic selection indices are critical to ranking cows and bulls to be parents of the next generation. This retrospective study was conducted to determine the relationship between average Linear Score (AVELS) of the SCC of the current lactation and the overall prevalence of intramammary infections (IMI) among cows within each one-log interval of AVELS using the standard LS scoring system. The main objective was evaluation of AVELS as a proxy variable for mastitis and therefore a potential tool for genetic selection in favor of bulls and cows whose offspring are less likely to contract IMI. For 65,229 cows with an AVELS for the current lactation recorded at the time that they also had milk culture performed, there was a significant positive association between the log intervals of AVELS and overall prevalence of IMI in cows within each log of AVELS. This relationship was found for the mastitis pathogens *Streptococcus agalactiae*, *Staphylococcus aureus*, streptococci other than *Strep. agalactiae*, *Escherichia coli*, *Klebsiella* spp., *Serratia* spp., yeast, *Prototheca* spp., *Arcanobacterium pyogenes*, and *Mycoplasma* spp. (chi-square, $P < 0.001$). For example, for cows with AVELS < 1.0 , the prevalences of *Streptococcus agalactiae*, *Escherichia coli*, and *Mycoplasma* spp. were 0.6%, 0.2%, and 0.0%, respectively; for cows with AVELS > 9.0 , their prevalence was 7.0%, 1.6%, and 0.8%, respectively. Overall prevalence of IMI was 18% for cows with AVELS < 1.0 , and increased to 74% for cows with AVELS > 9.0 . The heritability of mastitis characteristics range from .10-.17. This together with the demonstrated value of LS as an indirect indicator of mastitis suggests a need for increased weight given to average LS in genetic value estimate equations. Results will be presented and discussed in detail for 13 mastitis agents.

Key Words: Mastitis, Linear Score, Genetics

625 Dairy farmers and veterinarians: partners in profit. A.W. Jalvingh^{*}, CR Delta, Arnhem, The Netherlands.

Modern dairy farming imposes increasing demands on farmers' management skills to maintain profit and guarantee continuity of the farm. The role of the veterinarian on the dairy farm has over time moved from curing diseases to preventing diseases and managing risks. Farmer and veterinarian together form a perfect combination to improve the health status, and thus technical and economic results. To stimulate Dutch

farmers to use the veterinarian more as their advisor in problem analysis the project "Partners in Profit" was initiated. Partners in profit is a collaboration of CR Delta, a farmers' cooperative in cattle improvement, KNMvD, the Dutch society of vets, and Pfizer Animal Health, a pharmaceutical company. The basic idea is that participating vets receive information on participating farms based on data collected by CR Delta through milk recording, AI and other services. In the first year attention is focused on fertility, the second year on udder health and the third year on other health issues. In the first year 300 veterinary practices and 8000 dairy farmers are participating and will receive the first reports on fertility in February 2001. The vet receives a report with all the relevant parameters of the past year. One overview contains the average values for the practice as a whole and for the group participating farmers in the practice, and next to that the country averages are given and the averages of the group of farms with the 25% lowest values and 25% highest values. This report gives an idea of how the farmers in the practice on average are performing related to national averages and the observed variation. Next to that there is an overview which contains the basic farm figures over the past year from participating farms in the practice. Based on this information the vet can contact the farm without any further obligations. Vet and farmer together will decide whether they want to be partners in profit. For this second step, they can order an in-depth report, with figures for the last month, quarter, half year, year as well as target values. These in-depth reports form a good starting point for the analysis of the strong and weak points of the farm and to formulate further actions to improve the farm's health status.

Key Words: Information products, Herd Health Management, Dairy Farms

626 Evaluation of early detection of induced *Staphylococcus aureus* mastitis using infrared thermography. M. M. Schutz^{*1}, S. D. Eicher², J. M. Townsend¹, G. Shaw³, and D. M. Kocak³, ¹Purdue University, ²USDA-ARS, ³eMerge Interactive.

Increased blood flow and temperature increases may accompany initial immune response to a mastitic infection. The objective of this study was to determine whether infrared (IR) thermography could aid in early detection of mastitis by identifying these symptoms. Six multiparous, late-lactation Holstein cows were kept in a tie stall barn for nine days. Cows were separated by an empty stall and milked separately from other herdmates at 0600 and 1700. One forequarter of each of four cows was randomly selected and infused on d 5 with 450 cfu of *S. aureus* (Newbould). Infrared thermographs were taken from approximately 1.5 m of

each fore quarter and the rear quarters every .5 h for 2 h before and after each milking on all 9 d. A black body temperature standard was used to calibrate IR temperatures (IRT) before, amid, and after each series of images. Environmental conditions of temperature, humidity, and barometric pressure were recorded prior to collection of images to provide additional IR correction, if necessary. Rectal temperatures (RT) and bacteriological cultures were collected at scheduled days and times for mastitis detection using conventional methods. Challenged quarters were infused with cephalopine sodium for consecutive milkings upon observation of clinical mastitis, or on d 9. Three of four challenged cows developed clinical mastitis ($\chi^2=3$, $p=.08$, $DF=1$) although positive *S. aureus* cultures and elevated RT were noted only in two. Overall, patterns of IRT correlated to RT ($r=.58$, $t=52.5$, $p<.001$), but differences among quarters were apparent. IRT increases accompanied elevated somatic cell scores in challenged quarters ($r=.33$, $t=2.04$, $p<.05$), but not in other quarters ($r=-.33$, $t=-4.13$, $p<.001$). Adjustment of rolling average (12 and 24 h) RT and IRT for ambient temperatures accounted for diurnal variation. Results from this study show IRT can detect elevated temperatures associated with mastitis, but are unlikely to detect mastitis earlier or be more cost effective than existing methods.

Key Words: Mastitis, Infrared, Temperature

627 Effects of acidosis inducing diets on memory responses to viruses in Holstein steers. D. C. Donovan^{*1}, A. R. Hippen¹, and D.J. Hurley¹, ¹South Dakota State University, Brookings.

Cattle are more susceptible to infectious disease when acidotic. Susceptibility to disease is dependent on the level of infectious agent and the immune response to the agent. To evaluate the relationships between acidosis and immune responses, Holstein steers (220 +/- 43 kg) were used in a 4 x 4 Latin square examining the influence that acidosis inducing diets exert on memory responses to bovine viral diarrhea virus (BVDV), bovine respiratory syncytial virus (BRSV), parainfluenza type 3 (PI3), and bovine herpes virus (BHV-1) tested in vitro. Diets were designed to evaluate the effects of the metabolites, lactate and ketone bodies, or mineral salts in decreasing blood pH. Diets were defined as control (45% concentrate, C), high grain (100% concentrate, HG), supplemented with 1,3-butanediol (700 ml/d, BD), or anionic salts (dietary cation anion difference of -30 mEq/100 gm, AS). Data was collected on day 18 and 20 of each period. Blood pH was decreased in treated steers and the decrease was greatest in AS (7.38, 7.37, 7.32, and 7.36 for C, BD, AS, and HG, respectively; $P < 0.009$ for treatments; $P < 0.05$ for AS vs. C). Decreased T cell proliferation in response to *Staphylococcus aureus* exotoxin B was observed in treated steers (54816, 37654, 35226, and 29459 cpm for C, AS, BD, and HG; $P < 0.006$), but was not correlated to blood pH. Increased T cell memory response to BVDV stimulation was observed in treated animals (133, 2428, 1407, and 2429 cpm for C, AS, BD, and HG; $P = 0.11$), and was negatively correlated to blood pH ($r = 0.45$, $P < 0.01$). Increased T cell memory response to BRSV stimulation was observed in steers supplemented with BD (516, 244, 2051, and 336 cpm for C, AS, BD, and HG; $P = 0.06$), but was not correlated to blood pH. Memory response to PI3 tended to be increased in steers supplemented with AS (9, 174, 36, 25 for C, AS, BG, and HG; $P < 0.10$), and was strongly, negatively correlated with blood pH ($r = 0.51$, $P < 0.01$). Diets that induced an acidotic state, decreasing blood pH, had an effect on immunity. Memory of T cells was affected differentially in response to ketoacidosis and mineral acidosis. Therefore, acidosis may increase susceptibility to disease. The effects of acidosis on viral load remain to be evaluated.

Key Words: Acidosis, T Cell Memory, Virus

628 Association between retained placenta and blood interleukin-8 concentration and lack of association of retained placenta with energy and calcium metabolic profiles. Kayoko Kimura^{*1}, Jesse Goff¹, Timothy Reinhardt¹, and Shigeru Sato², ¹National Animal Disease Center, USDA-ARS, ²NOSAI Miyagi, Japan.

We previously reported that neutrophil function (chemotaxis and myeloperoxidase activity) of cows that would develop retained placenta (RP) was significantly decreased compared to neutrophil function of cows that expelled the placenta normally (No RP) (J Dairy Sci 83,Suppl.1:3) using 142 cows (20 RP, 122 No RP cows). Why neutrophil function of cows with RP is impaired remains unknown. We

hypothesized that the metabolic state of the cow prior to calving influences neutrophil function. Using plasma obtained during the cited study, we examined the relationship between energy or calcium status during the periparturient period and the development of RP. In addition an ELISA for interleukin-8 (IL-8), a cytokine critical to neutrophil chemotaxis and activation, was performed on a subset of 8 RP and 8 No RP cows. Plasma calcium and phosphorus concentrations decreased at calving to the same extent in both RP and No RP cows. Energy status at parturition, as assessed by plasma NEFA (0.53 ± 0.14 meq in RP and 0.67 ± 0.07 meq in No RP) and -hydroxybutyrate (8.76 ± 1.74 mg/dl in RP and 12.0 ± 1.90 mg/dl in No RP) concentrations were also essentially the same in both RP and No RP cows. IL-8 concentration at calving in plasma of No RP cows (125 ± 14 pg/ml) was significantly higher than in RP cows (61 ± 15 pg/ml). It remained higher throughout the first 2 weeks of lactation as well. Fetal cotyledons were collected within 4 h of calving in a subset of 3 RP cows and 15 No RP cows for histologic evaluation. Binucleate giant cells, thought to produce placental lactogen, are reported to be present in "retained" placenta and absent in placenta that are expelled normally. Binucleate giant cells comprised 14.7% of the total epithelial cells in retained placenta and 14.2% of epithelial cells in placenta expelled normally. We are unable to confirm previous reports suggesting retention of binucleate giant cells is a cause of RP. We also could not show an association between plasma calcium or energy status at calving and retained placenta. We did find further evidence that the immune system of the cow may be involved in RP as IL-8 concentration at calving was significantly lower in cows developing RP.

Key Words: Retained placenta, Interleukin-8, Binucleate giant cell

629 Impact of leptin on in vitro cytokine production during early and mid lactation. Gina M Pighetti^{*}, University of Tennessee, Knoxville, TN USA.

The ability of leptin to regulate energy stores within the body has allowed it to evolve and help regulate other energy-dense processes such as reproduction and immunity. However, very little if any information exists regarding the consequences of leptin on bovine immune function. Therefore, the objective of the current study is to compare the in vitro responses of peripheral blood mononuclear cells isolated from both mid-to-late (ML) and periparturient (PP; within 3 days after calving) dairy cows to leptin. Increasing doses of concanavalin A (0-2 ug/ml) and/or recombinant human leptin (0-50 ng/ml) were administered to the cells 12 hours prior to collection for RNA. Interferon (IFN)- γ and interleukin (IL)-4 mRNA were measured as indicators of cellular and humoral immunity, respectively. Preliminary evidence indicates that cells isolated from PP and ML cows respond in a similar fashion to leptin, but vary as to which concentrations they respond to. Leptin approximately doubled the relative expression of IFN γ mRNA in cells from ML cows, regardless of dose. In contrast, cells from PP cows only responded to the lowest leptin dose (1 ng/ml). Little, to no IL-4 mRNA was produced in stimulated cells collected from ML lactation cows. However, costimulation with a minimum of 5 ng/ml leptin increased IL-4 mRNA to levels comparable to IFN- γ . In contrast, it required 50 ng/ml to achieve the same effect in cells from PP dairy cows. These preliminary results indicate that immune cell populations are responsive to leptin and that this response can vary with the stage of lactation. Moreover, with the fluctuations in leptin that can occur with body condition and pregnancy, it is imperative to further investigate this link between leptin, energy metabolism/storage, and immune function in order to promote better animal health.

Key Words: Immunity, Leptin, Stage of lactation

630 Serum antibody responses in Holstein cows immunized five times with J5 Bacterin. K. Smith^{*}, C. Phipps, J.L. Burton, and R.J. Erskine, Michigan State University, East Lansing, MI.

In a previous study of J5 bacterin-immunized dairy steers, we observed significantly higher and more sustained serum IgM, IgG1, and IgG2 antibody responses when animals were immunized 5 times than when they were immunized 3 times. We also showed that the hyperimmune steer serum was highly effective at promoting neutrophil phagocytosis of opsonized *E. coli in vitro*. Because of the implications of these results for improved resistance to coliform mastitis in vaccinated dairy cows, we were curious to know if five immunizations with J5 bacterin (Pharmacia

and Upjohn, Kalamazoo, MI) would elicit better antibody responses in lactating cows than the currently recommended 3-immunization protocol. Therefore, our objective was to monitor anti-J5 antibody response profiles in dry and lactating Holstein cows immunized either 3 times ($n = 5$) or 5 times ($n = 5$) with J5 bacterin. All cows received the first 3 immunizations according to manufacturer's recommendation (5 ml of bacterin administered subcutaneously at dry off, at 30 days dry, and within a few days of calving), and the 5-shot group received two additional immunizations (5 ml) at 30 and 60 days in milk. Antibody response profiles were monitored (ELISA) on the 7th day following each immunization. Results showed that 3 immunizations caused modest increases in serum anti-J5 IgM and IgG1 antibodies that persisted until 60 days in milk, but was not effective in eliciting an IgG2 antibody response. Five immunizations caused an approximately 2-fold higher IgG1 antibody response than the 3-shot protocol, and successfully elicited IgG2 isotype switching. Based on these results we conclude that 5 immunizations of J5 bacterin may be more effective than 3 immunizations in eliciting higher, more sustained humoral immunity against coliform bacteria that cause mastitis.

Key Words: Hyperimmunization, J5 Bacterin, Antibody Responses

631 Changes in the Amino Acid Ratio and Ammonia Concentration in Plasma and Cerebrospinal Fluid of Dairy Cows suffering from Hepatosteatorrhea and Liver Failure. J. Rehage*, C. Meier, M. Kaske, and H. Scholz, *Veterinary School of Hannover, Hannover, Germany.*

Cows with liver failure develop clinical signs of a hepatic encephalopathy (HE), such as loss of appetite, general depression, ataxia, recumbency or even coma. The pathogenesis is still unclear. The objective was to study the amino acid ratio and ammonia concentrations in plasma and cerebrospinal fluid (CSF) in German HF cows with fatty liver and HE. The study included healthy controls ($N = 19$; age: 5.8 ± 1.2 years, liver triglyceride: 19.5 ± 3.2 mg/g FW [mean \pm s]; dry), uncomplicated fatty liver cows (group FL; $N = 12$; age: 5.1 ± 1.2 years; 14.3 ± 3.2 days p.p.; liver triglyceride: 57.2 ± 19.7 mg/g FW) and 31 cows with HE (age: 5.3 ± 1.2 years; 12.3 ± 3.9 days p.p.). Mild signs of HE showed 17 cows (group HE1; no appetite, general depression, ataxia; liver triglyceride: 65.3 ± 18.9 mg/g FW) and 14 severe HE (group HE2; recumbency, coma; liver triglyceride: 78.5 ± 23.5 mg/g FW). CSF was obtained lumbally, blood samples were taken from the jugular vein for amino acids (AA) and from the auricular artery for ammonia determinations. The amino acid pattern was measured by HPLC and the amino acid ratio was calculated from the concentrations [μ mol/L] of (VAL + LEU + ILE / (PHE + TYR)), ammonia was determined on an automated analyzing system. Compared to controls and FL cows in HE cows plasma levels of branched chain amino acids (VAL, ILE, LEU) decreased considerably and those of aromatic AA (PHE, TYR) increased slightly, whereas in CSF the increase in aromatic AA levels was most prominent. The mean amino acid ratio in plasma of controls, FL cows, HE1 and in HE2 was 6.4 ± 0.5 , 6.1 ± 0.5 , 3.5 ± 0.3 , 2.9 ± 0.4 ($p < 0.01$), and in CSF 6.2 ± 0.3 , 5.5 ± 0.4 , 2.8 ± 1.0 , 3.3 ± 0.6 ($p < 0.01$), respectively. Mean ammonia concentrations [μ mol/L] in controls, FL, HE1 and HE2 in plasma were 18.9 ± 8.7 , 20.5 ± 9.5 , 50.3 ± 12.8 , 65.8 ± 14.1 ($p < 0.01$), and in CSF 7.4 ± 3.8 , 11.1 ± 6.4 , 26.8 ± 10.7 , 33.5 ± 13.2 ($p < 0.01$), respectively. Results revealed that liver function in dairy cows has as in monogastric species a substantial impact on the plasma and CSF amino acid pattern as shown by the amino acid ratio and that the occurrence of HE is correlated to ammonia concentrations in plasma and CSF.

Key Words: Dairy cows, Ammonia, Amino acids

632 Growth Responses of *Escherichia coli* to Purified Immunoglobulin G from Cows Immunized with Ferric Citrate Receptor FecA. K. Takemura*, J. S. Hogan, and K. L. Smith, *Ohio Agricultural Research and Development Center, The Ohio State University.*

The effect of purified immunoglobulin (Ig) G from cows immunized with FecA on growth of *Escherichia coli* was investigated in an in vitro assay. Twenty-one cows were assigned to one of 3 treatments: 1) FecA immunized cows, 2) *E. coli* J5 immunized cows, and 3) unimmunized control cows. Immunizations were: 1) subcutaneous injection at 14 d prior to drying off, 2) intramammary infusion at 7d after drying off, and

3) subcutaneous injection at 28 d after drying off. FecA used to immunize cows was purified from *E. coli* UT5600/pSV66 by ion exchange chromatography. Protein G affinity chromatography was used to purify IgG from pooled colostrum whey from each treatment group. The whey from FecA immunized cows had significantly higher IgG titers against FecA compared with whey from *E. coli* J5 immunized cows and control cows. Fourteen isolates of *E. coli* from the cases of naturally occurring mastitis were cultured at 37°C for 6 h under iron restricted conditions in a chemically defined medium containing $200 \mu\text{M}$ α - α' -dipyridyl and 1 mM citrate. Bacterial cells were washed and resuspended in PBS to approximately 10^3 cfu/ml. The bacterial cells were mixed with purified IgG at concentrations of 0, 2, and 4 mg/ml and incubated at 37°C . Fifty μM FeCl_3 was added to the assay containing 4 mg/ml IgG to determine the effects of exogenous iron on bacterial growth. At 0, 6, 12, and 24h incubations, samples were taken and serially diluted to culture on MacConkey agar plates. Iron restriction decreased rates of the growth, but did not reduce peak bacterial counts. The presence of IgG decreased the growth of *E. coli* under iron restricted conditions; however, the growth did not differ among IgG sources nor between IgG concentrations. The addition of exogenous iron overrode the inhibitory effects of the iron depletion and the presence of IgG, but did not restore growth of *E. coli* to that comparable in iron replete control medium.

Key Words: Mastitis, FecA, IgG

633 Opsonic activity of serum and whey from cows immunized with the *Escherichia coli* ferric citrate receptor. A.J. Wise*, J.S. Hogan¹, and K.L. Smith¹, ¹*Ohio State University, OARDC-Wooster.*

The effect of immunizing dairy cows with the ferric citrate receptor (FecA) on the opsonic activity of serum and whey was measured in a phagocytosis assay. Fifteen cows were assigned to five blocks of three cows based on date of expected parturition. Cows within a block were randomly assigned to one of three treatments: 1) FecA immunization, 2) immunization with a commercially available *Escherichia coli* J5 bacterin, and 3) unimmunized controls. Immunizations were 1) subcutaneous injections fourteen days prior to the end of lactation, 2) intramammary infusion seven days after the end of lactation, and 3) subcutaneous injection twenty-eight days after the end of lactation. Cows were challenged approximately twenty-one days after parturition by intramammary infusion of *Escherichia coli* 727, a strain previously isolated from bovine mastitis. The phagocytosis assays included opsonizing *E. coli* 727 with either 10% heat-inactivated serum or 50% heat-inactivated whey from each cow. Immunization with FecA and the commercial bacterin increased antibody titers against *E. coli* 727 compared with control cows. Cows immunized with FecA had reduced clinical signs of mastitis following challenge compared with either cows immunized with *E. coli* J5 or unimmunized controls. However, sera and whey collected from cows immunized with FecA did not enhance opsonization of *E. coli* 727 compared with sera and whey from control cows. Immunization with the commercial bacterin increased opsonization of both sera and whey greater than immunization with FecA. Results of the current trial suggest that the protective effects of immunizing cows with FecA against bacterial challenge with *E. coli* 727 does not relate to enhanced opsonization and in vitro phagocytosis.

Key Words: Mastitis, *Escherichia coli*, Ferric Citrate Receptor

634 Opsonization of *Escherichia coli* cultured in iron-replete and iron-deplete media. A.J. Wise*, J.S. Hogan¹, and K.L. Smith¹, ¹*The Ohio State University, OARDC-Wooster.*

The effects of iron availability in culture medium on the opsonization of *Escherichia coli* by bovine sera were tested in an in vitro phagocytosis assay. Fourteen isolates of *E. coli* from bovine intramammary infections were tested. Isolates were cultured 16 h in trypticase soy broth as an iron-replete environment. Isolates were cultured 16 h in trypticase soy broth plus .2 mM dipyridyl and 1 mM citrate as an iron-deplete environment. Cultures were centrifuged and cells opsonized by 5% pooled bovine serum in HBSS. Opsonized bacteria were added to neutrophils at a 2:1 bacteria:neutrophil ratio and incubated 1.5 h at 37°C . Phagocytic indices were measured by direct microscopic count of neutrophils stained with acridine orange and crystal violet. A portion of bacterial cells cultured in both iron-replete and iron-deplete media was suspended separately in 6% dextrose and stained to determine the presence of a

capsule. Phagocytic index, percentage of neutrophils containing intracellular bacteria, and average number of intracellular bacteria per positive neutrophil were each greater for bacterial cells cultured in iron-replete medium compared with bacterial cells cultured in iron-deplete medium. Bacterial isolates positive for capsule were more resistant to phagocytosis than isolates that were capsule-negative. Iron availability in culture did not affect expression of a bacterial capsule. Culturing *E. coli* in iron-deplete medium increased resistance to phagocytosis by bovine neutrophils compared with culture in iron-replete medium.

Key Words: *Escherichia coli*, Opsonization, Iron

635 Oral glycerol as an aid in the treatment of ketosis/fatty liver complex. J.P. Goff^{*} and R.L. Horst, *USDA-ARS, National Animal Disease Center, Ames, IA.*

Glycerol can be converted to glucose in the liver of cattle. Glycerol enters the gluconeogenic pathway at the level of dihydroxyacetone phosphate and 3-phosphoglycerinaldehyde. This is several biochemical steps closer to glucose than the traditional gluconeogenic precursors, propionate and propylene glycol. Use of glycerol as an aid in the treatment of ketosis was suggested during the 1960s but not adopted due to high costs. New sources of glycerol have reduced the cost. We examined the effect of glycerol administration on blood glucose in dry cows and did a dose titration to determine the maximal tolerable dose. Treatment groups consisted of 3 cows (one of which had a rumen fistula) which were given 1, 2 or 3 L of glycerol via esophageal pump. Blood samples were taken hourly for the next 8 hrs and also at 24 hrs. At 0.5 hr after treatment mean blood glucose increased 16, 20, and 25% respectively over pretreatment values. They remained elevated for the next 8 hrs. All cows had returned to baseline glucose values at 24 hrs. Two of three cows given 3 L glycerol exhibited staggering and depression; from which they recovered from within 4 hrs. Rumen pH was unaffected by treatment with glycerol. Two lactating cows with clinical ketosis, which had been previously treated for 2 or 3 d with IV glucose with little response suggesting fatty liver involvement, were treated with 1 L glycerol. In both cases ketone level in urine was reduced to trace amounts by 24 h and milk production increased 4-6 lb. In the first cow blood glucose increased from 48 mg/dl to 75 mg/dl 0.5 hr after treatment and was 109 mg/dl 5 hr after treatment. In the second cow blood glucose did not increase until about 4 hr after treatment when it increased from 48 mg/dl to 74 mg/dl and was just 64 mg/dl 8 hr after treatment. Glycerol offers another means of treating cows for ketosis which may have less toxic effects than propylene glycol.

Key Words: glycerol, ketosis, gluconeogenic

636 Economic consequences of Johne's disease control programs on dairy herds in Pennsylvania. H. Groenendaal^{*} and D.T. Galligan, *University of Pennsylvania, School of Veterinary Medicine, Kennett Square, PA, USA.*

A stochastic simulation model called JohneSSim has been developed to evaluate different Johne's disease control programs on their epidemiological and economic consequences. The model was applied to infected farms in the Pennsylvania dairy industry. Input data were collected from literature or obtained from experts. The results showed that none of the 'test-and-cull' strategies alone are effective in reducing the Johne's disease prevalence. 'Test-and-cull' strategies have an average benefit-costs ratio of around 0.85 (5% and 95% percentiles are respectively 0.00

and 1.30) and are therefore economically not attractive. However, improved management and hygiene for calves until 12 months of age, is much more effective in reducing the prevalence. This reduction will gradually start after 3-5 years because of the long sub-clinical period, but will result in a prevalence close to 0, after 15-20 years. In addition, the 'management improvement' strategies result in significant economic benefits. On average, the benefits increase from none (in year 1) to US dollar 11,000 in year 20 for a 100 cow dairy herd. Furthermore, 'heifer contract rearing' appeared to be an effective, simple, cheap and therefore attractive way of reducing the Johne's disease prevalence under Pennsylvania conditions with economical benefits, similar to 'management improvement strategies'. It was concluded that only a complete improvement of the calf management can reduce the prevalence effectively, and is therefore critical in any Johne's disease control program.

Key Words: Johne's disease, Simulation, Economics

637 Using *Solanum glaucophyllum* as a source of 1,25-dihydroxyvitamin D to prevent hypocalcemia in dairy cows. R.L. Horst^{*1}, J.P. Goff¹, S. Gill², E. Pawlak², and M.E. Dallorso³, ¹*National Animal Disease Center, USDA-ARS, Ames, IA,* ²*CAE, Buenos Aires, Argentina,* ³*Universidad Nacional de Lomas de Zamora, Buenos Aires, Argentina.*

Reducing cation-anion difference of diets (DCAD) fed just before parturition can prevent milk fever. However this dietary regimen does not entirely eliminate hypocalcemia. Milk fever can also be prevented by exogenous administration of the calcium regulating hormone 1,25-dihydroxyvitamin D. Unfortunately 1,25-dihydroxyvitamin D treatment remains expensive and the pre-parturient diets used in most trials would be classified today as high in cations. *Solanum glaucophyllum* (SG) is a plant which contains high levels of a glycoside form of 1,25-dihydroxyvitamin D. Could administration of SG leaves to cows that were already being fed a low DCAD pre-parturient diet further improve calcium status at calving? Nine multiparous Jersey cows were fed a low DCAD diet prior to calving. Urine pH of cows was maintained below 7.0 in all cows the week prior to parturition. Five cows were daily given 2 or 3 g SG leaves in gelatin boluses beginning 6 days (on average) before calving and continuing for the first 14 days of lactation. None of the four cows fed the low DCAD diet developed milk fever. Their blood calcium concentrations were 7.6, 7.0 and 8.0 mg/dl the day of calving and d 1 and 2 after calving respectively. Cows receiving SG in addition to low DCAD diet had significantly higher blood calcium concentration during the periparturient period with blood calcium concentrations of 7.8, 8.8 and 9.3 mg/dl the day of calving and d 1 and 2 after calving respectively. Control cows suffered an average of 3 days of subclinical hypocalcemia (blood calcium < 7.5 mg/dl) and the SG treated cows suffered 0.8 d of subclinical hypocalcemia the first 2 wk of lactation. Thus SG treatment improved calcium status in animals that were also being fed a low DCAD diet. Unfortunately, all cows receiving SG suffered 1-2 days of hypocalcemia (1 cow developed milk fever) between 6 and 8 days after SG treatment was ended. Mean blood calcium on d 22 of lactation of SG cows was 6.9 mg/dl compared with 9.2 mg/dl in untreated cows. It appears that SG treatment supplanted calcium homeostasis mechanisms in cows so that withdrawal of treatment left the cows temporarily unable to control blood calcium concentration.

Key Words: milk fever, *Solanum glaucophyllum*, hypocalcemia

ASAS/ADSA Forages and Pastures: Silages

638 Corn plant and silage nutritive value in different stages of maturity. Jorgelina Ferrero^{*1}, Oscar DiMarco², Enrique Rossi², and Daniel Valle², ¹*Fac. Cs. Agrarias U.N.L.,* ²*Fac. Cs. Agrarias UNMdP-INTA Balcarce.*

The nutritive value of corn "fresh cut" (FC) and ensiled (S) whole plant, stalk and leaf blade was evaluated in three stages of maturity: milking (A), half milk line (B) and physiological maturity (C). Chemical composition, *in vitro* DM digestibility (IVDMD) and *in situ* DM and NDF degradability (48 h) of whole plant, stalk and leaf blade, before and after ensiling, were evaluated. Three silos of each fraction were made in each stage of maturity in plastic containers (5 liters), which were stored for 45 days. In addition, samples of stalk and leaf blade were ensiled

in each container by placing them in nylon mesh bags inside the whole plant silage. Data from each plant fraction were analyzed by a two factorial analysis of variance (stage of maturity and ensiling). Whole plant (FC) chemical composition was: 52.2 % NDF, 3.2 % starch and 17.3 % soluble sugars (CNES) in A, and 43.9 % NDF, 21.6 % starch and 20.9 % CNES in C. The concentration of CNES diminished in stalk with maturity from 27.4 in A to 18.2 % in C. The IVDMD of whole plant did not differ between stages of maturity (average: 66.8 %). IVDMD of stalk diminished between B and C (50.6 to 48.8 %, P<0.01), due to a lower concentration of CNES, and in leaf blade IVDMD decreased between A and B (65.2 to 56.7 %, P<0.01), due to a decrease in NDF quality. The *in situ* NDF degradability decreased (P<0.01) with maturity (A and

B) in stalk (41.8 to 38.2 %) and in leaf blade (70.9 to 57.6 %) without affecting whole plant DM degradability (72.8 %). Ensiling depressed CNES but did not affect NDF concentrations in whole plant, stalk or leaf blade. Significant interactions between maturity and ensiling were found for IVDMD and degradability (MS and NDF) in whole plant, stalk and leaf blade. It was concluded that the increase in starch accumulation with maturity compensated for the decrease in stover quality; and that care should be taken in extrapolation of results between data of fresh cut and ensiled corn.

Key Words: maize, silage, maturity stage

639 Evaluation of the nutritive value of low moisture corn silage stored in Ag Bag® vs bunker silos. J. H. Harrison*, D. Davidson¹, and D. Linder², ¹Washington State University, Puyallup, ²Ag Bag®, Warrenton, OR.

Pioneer® hybrid 39K72 was harvested on 10-22 and 10-23 -1999 as alternating loads in to a 3 meter Ag Bag® or 4.2 x 2.4 x 45 meter bunker silo. Average DM of the whole plant corn was 37% at ensiling. Each silo contained ~ 150 tons of silage. Silage temperatures were monitored at two locations at .3 and 1 meter depths in each silo. After 6 months of storage the two silages were compared in a 2 x 2 Latin square design lactation study with 2 week periods. Each group of cows had 24 cows and was fed diets that contained 26 % corn silage, 13 % alfalfa hay, 13 % whole cottonseed, and 52 % grain mix. The fermentation profile of Ag Bag® and bunker stored corn silages were: pH, 3.9 and 4.2; acetate % DM, 0.9 and 0.9; lactate % DM, 2.9 and 2.8, and ethanol % DM, .2 and .1, respectively. Average silage temp was 0.8 to 2.0°C cooler during storage for Ag Bag® silage. Data shown below support the conclusion that low moisture corn silage stored in an Ag Bag® system had greater nutritive value.

Silo	Milk, kg	Milk fat %	3.5 FCM, kg	Milk protein, %	Milk protein, kg
Ag Bag®	38.1	3.80	39.4	2.89	1.08
Bunker	37.6	3.61	38.2	28.6	1.07
P<	.17	.05	.06	.17	NS

Key Words: dairy, nutrition, corn silage

640 Evaluation of the nutritive value of processed corn silage harvested at three chop lengths. J.H. Harrison*, D. Davidson, and L. Johnson, Washington State University, Puyallup, WA/U.S.A..

Pioneer® hybrid 3845 was harvested from 10-20 through 10-22-1999 at three chop lengths (16, 28, and 40 mm) with a John Deere 5830 harvester equipped with kernel processor and ensiled in 3 m Ag Bag® silos. After 3 months of storage the three silages were compared in a continuous design lactation study beginning three weeks pre-partum through 10 weeks postpartum. Each group had 5 cows and were fed diets that contained 26% corn silage, 13% whole cottonseed, and 52% grain mix. Data summarized below indicate a trend for a time x chop length interaction with long chopped corn silage sustaining a greater intake of DM, less loss of BW, and greater 3.5% FCM. Milk protein content was greatest for cows consuming long chopped corn silage.

Silage	3.5 FCM, kg		Milk fat, %	Milk protein, %	BW, kg	BCS
	Milk, kg	DMI, kg				
16 mm	39.3	20.6	42.6	4.01	2.97	599
28 mm	39.6	20.3	42.7	4.07	2.80	617
40 mm	40.3	22.0	44.5	4.27	3.02	609
P ≤ Chop length	NS	NS	NS	.34	.08	NS
P ≤ Chop length x week	.29	.13	.15	NS	.03	.27

Key Words: dairy, nutrition, corn silage

641 Production response of Holstein cows fed diets containing annual ryegrass and corn silage with either ground or steam-flaked corn. J. K. Bernard*, J. W. West, and D. S. Trammell, The University of Georgia, Tifton, GA USA.

Twenty-four lactating Holstein cows were used in a 6-wk randomized design trial with a 2 x 2 factorial arrangement of treatments to determine

the effects of feeding ground (GC) or steam-flaked corn (SFC) in diets based on either annual ryegrass silage (RS) or a 50:50 blend of annual ryegrass and corn silages (BLEND). Cows were fed a basal diet during the first 2-wk of the trial and data were collected for covariate analysis. Experimental diets contained 49.6% forage and were formulated to contain equal concentrations of CP, NDF and energy. There were no interactions of forage and processing of corn. The mean DMI, milk yield, milk fat percentage, milk protein percentage, and energy-corrected milk (ECM) yield was 19.7 kg/d, 30.8 kg/d, 3.28%, 2.85% and 27.6 kg/d for cows fed RS and 22.3 kg/d, 31.5 kg/d, 3.41%, 2.78%, and 31.2 kg/d for cows fed BLEND. Cows fed BLEND consumed more DM (P < 0.001) and tended to produce more ECM (P < 0.09) due to numerically higher milk yield and milk fat percentage than those fed RS. Efficiency of converting DM to milk was greater (P < 0.01) for the diet based on RS compared to BLEND, but no difference was observed for efficiency of converting DM to ECM. There were no differences in BUN and glucose concentrations (P > 0.10) between forages. The mean DMI, milk yield, milk fat percentage, milk protein percentage, and ECM yield was 21.5 kg/d, 29.8 kg/d, 3.59%, 2.84% and 28.8 kg/d for cows fed GC and 20.4 kg/d, 32.5 kg/d, 3.10%, 2.78%, and 30.0 kg/d for cows fed SFC. Cow fed diets containing SFC consumed less DM (P < 0.04), but had higher milk yield (P < 0.004) that tended to have lower concentrations of fat (P < 0.10). Yield of milk protein was higher (P < 0.01) for cows fed SFC (0.90 kg/d) compared with cows fed GC (0.83 kg/d). Efficiency of converting DM to milk was greater (P < 0.005) when cows were fed SFC than GC. No differences were observed in efficiency of converting DM to ECM. Blood glucose concentrations were similar for cows fed either GC or SFC, but BUN was lower (P < 0.03) for cows fed SFC (15.6 mg/dl) than GC (18.2 mg/dl). Results of this trial indicate that feeding a blend of annual ryegrass and corn silage supports greater milk yield than feeding all ryegrass silage and that steam-flaked corn improved milk yield and utilization of DM over ground corn.

Key Words: Ryegrass silage, Corn silage, Steam-flaked corn

642 The effect of Lactobacillus buchneri 40788 and enzymes on the fermentation and aerobic stability of barley silage fed to lactating cows. C. C. Taylor*, J. A. Mills, J. M. Neylon, and L. Kung, Jr., University of Delaware, Newark, DE.

We investigated the effects of adding a heterofermentative lactobacilli, *L. buchneri*, to whole plant barley on the aerobic stability and the nutritive value of silage. Chopped barley (40% DM) was either treated or not treated with a combination of *L. buchneri* (LB, 400,000 cfu/g of fresh forage) and enzymes (Biotal, Inc., Eden Prairie, MN) and ensiled in a bag silo. About 40 t of forage was prepared for each treatment. The average concentration of acetic acid in treated silage was higher (6.68%, P < 0.05) than in untreated silage (2.69%, DMB) during the first 16 wk of ensiling. After 7 mo of storage, both ends of the bag silo were opened simultaneously and untreated and treated silages were fed to sixteen multiparous and eight primiparous Holstein cows producing about 26 kg of milk/d (124 ± 52 DIM; mean ± SD). Cows were fed a TMR comprised of 35% untreated or treated barley silage, 15% corn silage, and 50% (DMB) of a pelleted concentrate. The experiment was a crossover design consisting of two 21-d periods; the last week in each period was used for collection of production data. During feedout, barley silage treated with *L. buchneri* had higher concentrations of acetic acid (5.92 vs. 4.02%, DMB, P < 0.06), fewer yeasts (2.63 vs. 4.89 log₁₀ cfu/g, P < 0.05), and took longer to spoil when exposed to air (>190 vs. 66 h, P < 0.05) when compared to untreated silage. The aerobic stability of the TMR was longer (P < 0.05) when it contained treated (77 h) rather than untreated (46 h) barley silage. Dry matter intake (18.6 kg/d), milk production (25.7 kg/d), and milk composition did not differ between treatments. These findings show that *L. buchneri* can improve the aerobic stability of barley silage in farm-scale silos and high concentrations of acetic acid in treated silage did not reduce DMI. The data also show that mixing silage treated with *L. buchneri* into a TMR, can improve the aerobic stability of that TMR even though it contained corn silage that had not been treated.

Key Words: Lactobacillus buchneri, Silage, Aerobic stability

643 Adding *Lactobacillus buchneri* 40788 to alfalfa silage increases the production of acetic acid in laboratory and farm-scale silos and has no effect on the dry matter intake of high producing dairy cows. C. C. Taylor, M. P. Lynch, J. M. Neylon, T. L. Ebling*, and L. Kung, Jr., *University of Delaware, Newark, DE.*

We applied a heterofermentative lactobacilli, *L. buchneri*, and enzymes (Biotol, Inc., Eden Prairie, MN), to alfalfa silage (38% DM) and studied its effects on silage fermentation in lab and farm silos. Alfalfa was chopped and treated with nothing, or *L. buchneri* to obtain a final application rate of 1×10^5 , 5×10^5 , or 1×10^6 cfu/g of fresh forage. After 56 d of ensiling in lab silos, treated silages had higher ($P < 0.05$) concentrations of acetic acid (6.00 versus 4.24%), propionic acid (0.18 versus 0.06%), and ammonia N (0.346 versus 0.289%) than did untreated silage. Yeasts and molds were less than 2.00 log₁₀ cfu/g in all silages. In a subsequent experiment, alfalfa (43% DM) was not treated or treated with *L. buchneri* (5×10^5 cfu/g) and enzymes and stored in a bag silo for 4 mo before feeding. Twenty four multiparous and six primiparous cows (86 11 DIM) were fed a diet comprised of 32% untreated or treated alfalfa silage, 11% corn silage, 5% chopped alfalfa hay, and 52% of pelleted concentrate (DMB) for a 6-wk treatment period. Dry matter intake (25.2 kg/d), milk production (40.3 kg/d), and milk composition were unaffected by treatment. During feed out, treated silage had a higher pH (4.66 vs. 4.36, $P < 0.05$) and higher concentration of acetic acid (5.69 vs. 3.38%, $P < 0.05$), but lower lactic acid (5.26 vs. 6.58%, $P < 0.05$) than untreated silage. Yeasts and molds were less than 2.00 log₁₀ cfu/g for both alfalfa silages but was 6.11 and 5.72 log₁₀ cfu/g in corn silage, respectively. Alfalfa silages, alone, did not heat but the TMR containing untreated silage heated after 69 h whereas the TMR containing the silage treated with *L. buchneri* did not heat until 100 h ($P < 0.05$). These data show that treating alfalfa silage with *L. buchneri* increases the concentration of acetic acid and when the silage mixed with other feeds, it can improve the aerobic stability of the TMR.

Key Words: *Lactobacillus buchneri*, Silage

644 Evaluation of nutrient composition and IVDMD of alfalfa and/or tropical grasses grown in Hawaii and harvested as round bale silage. D.T. Harauchi*, J.R. Carpenter, R.J. Early, and C.N. Lee, *University of Hawaii-Manoa.*

Currently, much of the nutritional composition data available in Hawaii has come from samples taken from outside the State. Since the current data from most forages have come from temperate climates, the objective of this study was to expand a database of nutrient composition for locally grown forages used for dairy rations. The samples consisted of alfalfa (*Medicago sativa*), guinea grass (*Panicum maximum*), green panic (*P. maximum* var. *trichoglume*), klein grass (*Panicum coloratum*), or a combination of these forages. The silage was grown in Wailua on the northern coast of Oahu and harvested between September 1997 and December 1998 at varying stages of regrowth. The ensiled samples were obtained from Dole Food Co. and CP, NDF, and ADF were determined using NIRs (NIRSystems Model 6500). DM, and ash were determined using AOAC techniques, and 48h IVDMD by Ankom procedures. A fistulated steer fed alfalfa cubes ad libitum was used as the source of rumen inoculum (4 h post-prandial). A total of 289 samples were separated according to forage type and different stages of maturity (<4, 4-5, 5-6, >6 weeks) to determine the effect of species and age of regrowth on digestibility. The mean DM was 47.1, and the % ash, CP, NDF, ADF and IVDMD for the 289 samples (DM basis) was 8.1, 17.4, 52.2, 34.4, and 76.6, respectively. NDF and ADF were lower ($P < .01$) for alfalfa (41.6 and 31.0%, respectively) than alfalfa/guinea (50.6 and 35.6%) and these were all lower than the other grasses (68.3 and 38.9%). 48h IVDMD, DM, and ash showed no significant difference between the grasses. The CP was highest ($P < .01$) for alfalfa (21.8%) followed by alfalfa/guinea mix (17.8%), green panic/guinea (13.6%), klein/guinea (10.9%) and other mixed grasses (9.3%). NDF values were higher ($P < .01$) with each increase in age of regrowth, and IVDMD was higher ($P < .01$) for the alfalfa and alfalfa guinea mix than the other grasses at all ages except for 5-6 wk where no differences were observed.

Key Words: Alfalfa and tropical grass silages, Nutrient composition, IVDMD

645 The effect of inoculation with *Lactobacillus plantarum* MTD1 and packing density on the fermentation of high DM alfalfa silage. M. P. Lynch*, J. A. Lazartic, J. M. Neylon, C. C. Taylor, M. A. Reddish, and L. Kung, Jr., *University of Delaware, Newark, DE.*

We investigated the effect of packing density and microbial inoculation on the fermentation of alfalfa silage with a high DM content. Alfalfa was wilted to 53% DM before chopping. Treatments were: 1) untreated, tightly packed (411 kg/m³, DMB) (UT), 2) inoculated with *Lactobacillus plantarum* MTD1 (Ecosyl Products, Ltd., Stokesley, England; 100,000 cfu/g of fresh forage), tightly packed (LPT), 3) untreated, loosely packed (205 kg/m³) (UL), or 4) inoculated, loosely packed (LPL) in laboratory silos. After 8 d of ensiling, LPT had higher ($P < 0.05$) concentrations of lactic acid, but lower ($P < 0.05$) concentrations of ammonia N and acetic acid than did UT. In contrast, UL had a higher pH (5.60 vs. 5.31, $P < 0.05$), a lower concentration of lactic acid (1.28 vs. 2.49%, $P < 0.05$), and fewer lactic acid bacteria (8.23 vs. 8.67 log₁₀ cfu/g, $P < 0.05$) than did UT. Adding homolactic acid bacteria to loosely packed silage (LPL) increased the concentration of lactic acid and decreased acetic acid ($P < 0.05$) when compared to UL, but the effect was intermediate ($P < 0.05$) to that of LPT. After 42 d of ensiling (see table), untreated, loosely packed silage (UL) had a higher ($P < 0.05$) pH, a lower ($P < 0.05$) concentration of lactic acid, and more ($P < 0.05$) yeasts and molds than did UT. Microbial inoculation overcame the detrimental effects of loose packing (LPL) by causing a more ($P < 0.05$) predominant homolactic acid fermentation. However, inoculation of loosely packed silage could not prevent the accumulation of yeasts and molds that were undetectable in tightly packed silage (UT and LPT).

Item	UT	LPT	UL	LPL	SE
pH	4.61 ^b	4.27 ^c	5.04 ^a	4.29 ^c	0.01
Lactic acid, %	4.19 ^b	5.63 ^a	3.24 ^c	5.36 ^a	0.14
Acetic acid, %	1.88 ^a	0.69 ^d	1.48 ^b	1.02 ^c	0.07
Ammonia N, %	0.11 ^a	0.05 ^c	0.08 ^b	0.05 ^c	0.01
Yeasts, log ₁₀ cfu/g	0 ^c	0 ^c	5.71 ^a	5.72 ^b	0.34
Molds, log ₁₀ cfu/g	0 ^c	0 ^c	6.19 ^a	4.43 ^b	0.25

^{a,b,c,d} Means in rows with unlike superscript differ ($P < 0.05$).

Key Words: Packing density, Inoculation, Silage

646 Why digestibility of alfalfa stems declines with maturity. H. G. Jung*¹ and F. M. Engels², ¹USDA-ARS, St. Paul, MN, ²Wageningen University, The Netherlands.

Development of an alfalfa stem internode from three genotypes was examined to determine why digestibility of alfalfa stems declines with maturity. The seventh internode from the stem base was collected from replicated field plots at five stages of development (12, 17, 21, 31, and 87 d of summer regrowth). Internode samples were preserved in alcohol for microscopic analysis and freeze-dried for cell wall (CW) and in vitro digestibility analysis. While minor genotypic differences were noted, the general pattern of development and digestibility was similar for the genotypes so only means are presented. Young, elongating internodes (12 and 17 d) had thin, nonlignified CWs in all tissues except primary xylem vessels which were already lignified. Internode elongation was complete by 21 d of regrowth, at which time there was some deposition of xylem fibers and this tissue was lignified. Further maturation (31 and 87 d) consisted of xylem tissue proliferation by cambial activity, and lignification of primary phloem and pith parenchyma tissues. CW concentration increased with maturity. Pectin (Pec) concentration in the CW declined while cellulose (Cel), hemicellulose (Hemi), and lignin (Lig) all increased with maturation. Major CW changes occurred when internode elongation ceased. All alfalfa stem tissues were completely digested in the two youngest maturity stages, except primary xylem vessels. Xylem fiber remained undigested after 21 d of regrowth and amount of undigested xylem increased with maturity. Some primary phloem and pith parenchyma tissues were undigested in the two oldest samples. CW polysaccharide digestion declined steadily from 17 to 87 d of regrowth. Xylem fiber was lignified as soon as it was formed and was almost completely indigestible. Proliferation of xylem fiber accounts for the increase in stem mass and reduction in alfalfa stem digestibility with maturity.

Trait	12 d	17 d	21 d	31 d	87 d
CW, % OM	37.1 ^a	50.2 ^b	65.3 ^c	71.1 ^d	72.4 ^d
Cel, % CW	33.9 ^a	34.5 ^a	40.1 ^b	42.1 ^c	40.2 ^b
Hemi, % CW	12.2 ^a	13.4 ^b	16.7 ^c	18.2 ^d	19.0 ^e
Pec, % CW	43.7 ^a	42.1 ^a	27.4 ^b	20.5 ^c	20.3 ^c
Lig, % CW	10.1 ^a	10.0 ^a	15.8 ^b	19.3 ^c	20.4 ^c
Polysaccharide Digestibility, %					
12-h	-	84.1 ^a	66.9 ^b	46.4 ^c	39.3 ^d
96-h	-	91.4 ^a	79.7 ^b	65.6 ^c	49.3 ^d

Means in the same row not sharing a superscript are different ($P < 0.05$).

Key Words: Alfalfa, Digestibility, Maturity

647 Nutrient composition of several brown midrib and non-brown midrib sorghum varieties. J. B. Banta*, F. T. McCollum, B. Bean, D. Pietsch, and M. Rowland, *Texas A & M University System*.

ABSTRACT: Nutritional constituents were compared in sorghum harvested for silage. The study included 17 brown midrib (BMR) and 48 non-BMR sorghum varieties. Varieties were randomly assigned to plots (four 0.762 m rows by 7.62 m long) in three replications. The varieties were planted on May 24, 2000, at a depth of 3.81 cm and 296,400 plants/ha. Fertilizer N was applied at 202 kg actual N/ha and Bicep II Magnum was applied immediately after planting. The soil type was a Pullman clay loam with a pH of 7.4. The varieties were grown under full irrigation. Harvest occurred on August 30, September 6, or September 27, when each entry was at the soft-dough stage. Forage samples were collected from 1 m of row in each plot, weighed, chopped and subsampled. Supsamples were immediately frozen and sent to the Dairy One Laboratory (Ithaca, New York) for analysis. The samples were analyzed using near infrared spectrometry and in vitro techniques. All varieties were ranked from most desirable (1) to least desirable (65) for each constituent. Mean nutrient values and ranks for BMR were more desirable than for non-BMR. However, based on individual variety data there was overlap between the two forage types. Hence, selection of a sorghum based solely on the BMR trait does not guarantee a more desirable nutrient profile.

	CP, %	ADF, %	NDF, %	Lignin, %	IVDMD, %
BMR					
mean	7.2	26.10	44.8	3.1	81.7
mean rank	27	26	26	15	16
non-BMR					
mean	6.7	28.4	48.1	4.4	75.4
mean rank	37	36	36	39	40
P-value	0.019	0.009	0.013	0.0001	0.0001

Key Words: Sorghum Silage, Digestibility

648 Performance of lactating dairy cows fed red clover based diets augmented with normal or brown midrib corn silage. P.C. Hoffman*¹ and L.M. Bauman¹, ¹*University of Wisconsin-Madison*.

Red clover (RC), normal corn silage (CS), and brown mid-rib corn silage (BMR) were harvested at recommended stages of maturity and ensiled. Eighteen early lactation (57±37 DIM) primiparous (N=9) and multiparous (N=9) Holstein cows were fed diets with forage bases of 100% RC, a 50:50 ratio of RC and CS, and a 50:50 ratio of RC and BMR. Concentrate mixtures were formulated for RC, CS, and BMR and fed at 56.0, 50.0 and 50.0% of dietary DM to yield isofibrous (NDF) and isonitrogenous diets. Lactation performance, feed intake, and milk protein fractions were evaluated. Numerically, RC contained more CP, NDF, and lignin than CS or BMR. The in vitro (IV) DM and NDF digestibility (D) of BMR was numerically higher than CS and was substantially higher than RC. There were no parity but treatment interactions, therefore data from primiparous and multiparous cows were combined. Cows fed CS and BMR produced more ($P < 0.07$) milk and consumed more ($P < 0.01$) DM than cows fed RC. Cows fed BMR consumed ($P < 0.05$) more DM than cows fed CS. Milk fat%, protein%, or casein% was not different between cows fed RC, CS, or BMR. Data suggested DM intake

and milk yield of lactating dairy cows fed red clover can be enhanced by addition of CS or BMR to the diet.

Item	RC	CS	BMR	SE	$P <$
Forage Quality					
CP, % DM	20.9	10.1	8.7	. . . . .
NDF, % DM	53.7	39.8	39.0	. . . . .
Lignin, % DM	6.2	2.6	2.2	. . . . .
IVDMD, % DM	71.2	82.1	87.3	. . . . .
IVNDFD, % NDF	46.2	55.0	67.5	. . . . .
Performance					
Milk yield, kg/d	31.9	33.2	33.2	0.48	0.07
Milk fat, %	3.91	3.84	3.74	0.06	0.18
Milk protein, %	3.13	3.17	3.17	0.02	0.21
Casein, %	2.52	2.60	2.49	0.05	0.35
DMI, kg/d	20.6	22.1	23.3	0.30	0.01

Key Words: Red clover, Lactation, Corn silage

649 The effect of applying a buffered propionic acid-based preservative (Ki-112) alone or in combination with a mixture of homolactic acid bacteria (HAB) on the fermentation and aerobic stability of high moisture corn. J. M. Neylon*¹, C. L. Myers², C. C. Taylor¹, J. A. Lazartie¹, and L. Kung, Jr.¹, ¹*University of Delaware, Newark, DE*, ²*Kemin Industries, Des Moines, IA*.

The objective of this study was to evaluate the effect of applying Ki-112 alone or in combination with HAB on the fermentation and aerobic stability of ground, high moisture corn (29% DM) ensiled in lab silos. Treatments were: 1) no additive, 2) 0.1% (fresh forage weight) Ki-112 (a propionic acid-based additive, Kemin Industries, Des Moines, IA), 3) 0.2% Ki-112, 4) HAB, which was comprised of *Lactobacillus plantarum*, *L. bulgaricus*, and *L. acidophilus* to obtain 100,000 cfu/g of fresh forage weight (Kemin Industries), 5) 0.1% Ki-112 + HAB, and 6) 0.2% Ki-112 + HAB. The inoculant and chemical additive were applied separately in treatments 5 and 6. The addition of Ki-112 and HAB, alone or in combination, had few effects on the fermentation of high moisture corn during the early stages of ensiling. Similar to concentrations in freshly treated corn, treatments containing Ki-112 had greater concentrations of propionic acid than untreated corn after 120 d of ensiling. Numbers of yeasts were 4.16 log₁₀cfu/g in untreated corn and were less ($P < 0.05$) than 2.00 log₁₀cfu/g in corn that was treated with 0.2% Ki-112. HAB alone, did not affect the numbers of yeasts (3.92 log₁₀cfu/g) in high moisture corn. Corn treated with only 0.1% Ki-112 (161 h, $P < 0.10$) and 0.2% Ki-112 (218 h, $P < 0.05$) was more stable when exposed to air than untreated corn (122 h). Treatment with only HAB or HAB + 0.1% Ki-112 did not affect the aerobic stability of corn. However, treatment with HAB + 0.2% Ki-112 markedly improved the aerobic stability (> 400 h, $P < 0.05$) of corn. Data from this study indicates that application of Ki-112 at 0.2% of fresh weight is required to improve the aerobic stability of high moisture corn. A microbial inoculant, alone, had no effect on aerobic stability, but when combined with the 0.2% Ki-112, stability was markedly improved.

Key Words: Propionic acid, Aerobic stability, Silage

650 Evaluation of the replacement value of HMEC for steam rolled corn grain. J. H. Harrison*¹, D. Davidson¹, D. Linder², and F. Hosington³, ¹*Washington State University, Puyallup*, ²*Ag Bag® Int., Warrenton, OR*, ³*Dari-Tech Services, Kent, WA*.

Pioneer[®] hybrid 3489 was grown in George, WA in 1999 for harvest as high moisture ear corn (HMEC) or dry grain. The planting date was ~ April 23 and harvest date for HMEC (31% moisture) was October 26. The grain corn was harvested ~ 2 weeks later and artificially dried. The HMEC was harvested with a Claas 860 chopper equipped with a kernel processor. The HMEC was ensiled in a 3 meter Ag Bag[®] and treated with Pioneer[®] 1189 inoculant. The dry corn grain was steam rolled prior to feeding. The two forms of corn grain were fed in a 4 x 4 Latin square design trial with 14-day periods. Cows averaged 104 DIM at the onset of the experiment and all cows received rBST on day 4 of each period. The four dietary treatments were ratios of HMEC:steam rolled corn of: 1) 100:0, 2) 75:25, 3) 25:75, and 4) 0:100 to provide 25 % of diet DM. The

12 hr macro in situ digestibility of starch and NDF of HMEC and steam rolled corn grain was: 18, 77, 22, and 69, respectively. The data shown below supports the conclusion that 25 % of steam rolled corn could be replaced with HMEC.

Item	Ratio				P _≤
	100:0	HMEC:steamed 75:25	rolled corn 25:75	0:100	
Milk, kg	34.9	37.2	38.6	38.7	NS
Milk fat, %	3.46 ^c	3.69 ^{bc}	3.85 ^{ab}	3.73 ^b	.12
3.5 /% FCM, kg	34.7 ^c	38.1 ^{bc}	40.8 ^{ab}	40.1 ^{ab}	.19
Milk fat, kg	1.21 ^c	1.36 ^{bc}	1.49 ^{ab}	1.44 ^{ab}	.12
Milk protein, %	2.99	2.97	3.00	2.92	NS
Milk protein, kg	1.04	1.11	1.15	1.12	NS

Key Words: dairy, nutrition, high moisture ear corn

ASAS/ADSA Ruminant Nutrition: Feedlot

651 Effects of supplemental phosphorus concentrations on inorganic phosphorus serum concentrations, growth performance, carcass characteristics, and cost of gain of finishing cattle. Wendy R. Flatt*¹, Tim Stanton¹, Jessica Davis¹, and Dave Schutz², ¹Colorado State University, ²CSU-Eastern Colorado Research Center.

ABSTRACT: The objective of this study was to evaluate the effects of dietary phosphorus (P) concentration on cattle growth, performance, blood serum levels and carcass characteristics. Two hundred and twenty-one beef cattle (119 heifers, 102 steers) with an average initial live weight of 296 ± 70.5 kg were used in a randomized experimental design. Calves were randomized by live weight, stratified by breed, and assigned to one of two treatments (four pens/treatment). Control (C) was fed at 0.34% (DM basis) for 147 days on feed (DOF). Low phosphorus (LP) cattle were fed at 0.34% P (DM basis) until day 85 at which time supplemental P was dropped to 0.24% until finish. Over the 147 d feeding period, feed intake was not affected (P > 0.05) by P level. Feed intake was 9.30 and 9.32 kg DM (± 0.02kg) of feed per day for C and LP, respectively. Average daily gain, although not significant (P > 0.05), was higher for cattle on C compared to cattle on LP (1.64 vs. 1.60 ± 0.04 kg/day). Feed efficiency was not affected by P treatments. No significant differences were determined between serum levels of inorganic P of cattle on C vs. LP. Dressing percent, hot carcass weight, muscling score, percent grading choice, and yield grade were not affected by the level of dietary P in the supplement. However, percent dark cutters for C and LP were significantly different as the percent not grading because they were dark cutters was 4.50% for cattle on C vs. 13.64% for cattle on LP. The calves on LP also had a higher (P < 0.05) incidence of morbidity than those calves on C, 13.51% vs. 4.50%, respectively. Reducing supplemental P from the diet at reimplant time may increase the incidence of morbidity and dark cutters.

Key Words: Phosphorus, Dark cutters, Feed efficiency

652 Effects of wet corn gluten feed and intake level on diet digestibility and rumen passage rate in steers. S. P. Montgomery*, J. S. Drouillard, E. C. Titgemeyer, J. J. Sindt, T. B. Farran, J. N. Pike, C. M. Coetzer, A. M. Trater, and J. J. Higgins, Kansas State University, Manhattan..

Twelve ruminally cannulated Jersey steers (534 ± 52 kg BW) were used in an incomplete Latin square design experiment with a 2 × 2 factorial arrangement of treatments to determine effects of wet corn gluten feed (WCGF) and total DMI level on diet digestibility and rumen passage rate. Treatments consisted of diets formulated to contain 40% WCGF or no WCGF, fed once daily either ad libitum or limited to 1.6% of BW. Two consecutive 24-d periods were used, consisting of 18 d for adaptation, 4 d for collection, and a 2-d in situ period. Chromic oxide (10 g/hd) was fed as a digestibility marker, and steers were pulse dosed with Yb-labeled alfalfa hay and a Co-EDTA solution via rumen cannula to measure solid and liquid passage rates. Dacron bags containing 5 g of either steam-flaked corn, WCGF, or ground (2-mm) alfalfa hay were placed into the rumens of all steers and removed after 3, 6, 12, or 48 h. WCGF increased total tract digestion of OM and NDF (P < 0.01), reduced total VFA concentration (P < 0.01), increased rumen NH₃ concentration (P < 0.01), increased rumen pH (P < 0.01), and tended (P < 0.06) to increase total tract digestion of starch. WCGF also increased rumen passage rate of solid digesta (P < 0.01). Limit feeding reduced (P < 0.01) total tract digestion of both OM and NDF, reduced total VFA concentration (P < 0.01), increased rumen NH₃ concentration (P < 0.01), and increased rumen liquid passage rate (P < 0.02). Total tract

digestion of starch was not affected by DMI level (P > 0.70). A DMI level × h interaction (P < 0.01) occurred for rumen pH. Limit feeding increased rumen pH at 0 and 12 h after feeding, but reduced rumen pH 4 h after feeding. WCGF or DMI level did not affect (P > 0.25) rate of in situ DM disappearance. This study suggests that WCGF increases OM and NDF digestion, and that limit-feeding high-energy diets once daily may depress OM and NDF digestion.

Key Words: Wet corn gluten feed, Limit feeding, Digestibility

653 Performance of beef heifers limit-fed growing diets containing alfalfa hay and wet corn gluten feed. S. P. Montgomery*, J. S. Drouillard, J. J. Sindt, T. B. Farran, J. N. Pike, C. M. Coetzer, H. J. LaBrune, A. M. Trater, and R. D. Hunter, Kansas State University, Manhattan..

Crossbred beef heifers (n = 339, BW = 277 ± 11.4 kg) were used in a randomized complete block design to determine optimum combinations of alfalfa hay (AH) and wet corn gluten feed (CGF) in limit-fed growing diets containing steam-flaked corn. Heifers were fed a common diet ad libitum for 15 d preceding the growing study to minimize differences in gastrointestinal tract fill. Heifers were then blocked by weight and allotted to pens containing four to seven head per pen, with six pens per treatment. Treatments consisted of diets containing 10, 20, or 30% ground AH, and 0, 40, or 68% CGF in a 3 × 3 factorial arrangement. All diets provided 33 mg/kg of monensin and were fed once daily at 1.6% of BW for 84 d. On d 8, 22, 37, 51, 64, and 79, unconsumed feed was removed from feed bunks 2 h after feeding, weighed, and returned to the respective feed bunk in order to measure rate of DMI. Prior to obtaining final weights, cattle were fed a common diet ad libitum for 15 d. An interaction occurred (P < 0.05) between level of AH and CGF level for both ADG and gain efficiency. ADG for the 99-d growing study were 1.03, .96, .90, .90, .88, .84, .85, .90, and .78 ± 0.02 kg/d and gain efficiencies were .196, .185, .175, .171, .172, .160, .163, .180, and .153 ± 0.004 kg gain/kg DM for 10AH/0CGF, 10AH/40CGF, 10AH/68CGF, 20AH/0CGF, 20AH/40CGF, 20AH/68CGF, 30AH/0CGF, 0AH/40CGF, and 30AH/68CGF, respectively. Increasing the levels of AH or CGF reduced cattle performance with the exception of 30AH/40CGF, which supported ADG similar (P > 0.10) to 20AH/0CGF or 30AH/0CGF, and improved gain efficiencies (P < 0.05) compared to 30AH/0CGF. DMI 2 h after feeding increased linearly (P < 0.01) with increasing AH, and decreased linearly (P < 0.01) with increasing CGF. This study suggests that 40% CGF can effectively replace steam-flaked corn in limit-fed growing diets containing 20 or 30% AH.

Key Words: Wet corn gluten feed, Alfalfa hay, Limit feeding

654 Wet corn gluten feed and alfalfa hay combinations in steam-flaked corn finishing diets. J. J. Sindt*¹, J. S. Drouillard¹, S. P. Montgomery¹, J. N. Pike¹, T. B. Farran¹, C. M. Coetzer¹, T. J. Kessen¹, and R. T. Ethington², ¹Kansas State University, Manhattan, ²Minnesota Corn Processors, Marshall, Minnesota.

A 153-d finishing experiment was conducted using 631 heifers (BW = 284 ± 7.9 kg) to determine optimum combinations of wet corn gluten feed (WCGF) and alfalfa hay in steam-flaked corn based diets. Heifers were randomly allocated to pens and stratified by weight to six treatments (2 pens per diet, 48 to 58 heifers per pen). Diets contained 25, 35, or 45% WCGF and 2 or 6% alfalfa hay (25/2, 25/6, 35/2, 35/6,

45/2, and 45/6) on a dry basis in a 2 × 3 factorial arrangement of treatments. Heifers were allowed *ad libitum* access to diets fed once daily. Heifers were implanted with Synovex C on d 1 and were adapted to final finishing diets within 21 d. Final diets provided 300 mg Rumensin, 90 mg Tylosin, and 0.5 mg MGA per heifer daily. On d 56 heifers were re-implanted with Synovex Plus. DMI (7.6, 7.8, 7.9, 8.1, 7.8, and 8.0 kg/d), and ADG (1.15, 1.16, 1.16, 1.17, 1.15, and 1.14 kg) were similar ($P > 0.19$) for cattle fed 25/2, 25/6, 35/2, 35/6, 45/2, and 45/6, respectively. Gain efficiencies (.152, .149, .146, .144, .147, and .143 kg gain/kg DM) decreased ($P < 0.05$) linearly as the level of WCGF increased. Carcass weights and dressing percent were not different ($P > 0.18$) among dietary treatments. A WCGF × alfalfa hay interaction occurred ($P < 0.10$) for ribeye area. For heifers fed 2% alfalfa hay, ribeye area increased with increasing dietary WCGF, however, for heifers fed 6% alfalfa hay ribeye area decreased with additional WCGF. Fat thickness (1.22, 1.22, 1.19, 1.27, 1.09, and 1.14 cm) for cattle fed 25/2, 25/6, 35/2, 35/6, 45/2, and 45/6, respectively, decreased ($P < 0.10$) linearly with increasing dietary WCGF. Incidence of liver abscesses (2.7, 4.7, 1.9, 0.9, 2.8, and 2.9%) for heifers fed 25/2, 25/6, 35/2, 35/6, 45/2, and 45/6, respectively, was lowest ($P < 0.05$) for heifers fed 35% WCGF. Alfalfa hay fed at 2% of diet dry matter is sufficient roughage in steam-flaked corn diets containing 25, 35 or 45% WCGF.

Key Words: Finishing Cattle, Wet Corn Gluten Feed, Roughage Level

655 Wet corn gluten feed and alfalfa hay combinations in steam-flaked corn finishing diets: effects on ruminal characteristics and diet digestibility. J. J. Sindt*, J. S. Drouillard, E. C. Titgemeyer, S. P. Montgomery, J. N. Pike, C. M. Coetzer, and T. B. Farran, *Kansas State University, Manhattan.*

Ruminally cannulated, mature Jersey steers ($n = 12$, BW = 585 ± 48 kg) were fed steam-flaked corn- (SFC) based finishing diets containing combinations of wet corn gluten feed (WCGF) and alfalfa hay (AH) to determine diet digestibility and ruminal characteristics. Dietary treatments consisted of 25 or 45% WCGF and 0, 2, or 6% AH in a 2 × 3 factorial arrangement. An incomplete Latin square design was used with three 14-d periods each containing a 10-d adaptation and a 4-d sampling period. Steers were offered *ad libitum* access to diets fed once daily. Chromic oxide (15 g) was fed as a digestibility marker, and Co-EDTA was pulse dosed to measure rumen liquid passage rate. WCGF, SFC, and AH were ruminally incubated in Dacron bags and removed at 0, 3, 6, 12, and 48 h on d 12 and 13. Feeding 45% WCGF reduced ($P < 0.05$) total tract digestibility of OM and tended to increase ($P < 0.10$) ruminal pH. The undegradable fractions of AH, SFC, and WCGF were decreased ($P < 0.06$) by feeding 45% WCGF. Total VFA concentrations decreased ($P < 0.05$) quadratically, whereas NH₃ and butyrate increased ($P < 0.05$) quadratically with increasing dietary AH. pH, acetate, and acetate: propionate increased ($P < 0.05$) linearly in response to additional AH, whereas propionate decreased ($P < 0.01$) linearly and the undegradable fraction of SFC *in situ* tended ($P < 0.10$) to decrease linearly as the level of AH increased. Rate of liquid passage tended ($P < 0.12$) to increase linearly with increasing dietary AH. A WCGF × AH interaction existed ($P < 0.05$) for turnover time (TT). For steers fed 25% WCGF, TT increased linearly as AH increased, but for steers fed 45% WCGF, TT decreased linearly with increasing amounts of AH. Few interactions existed between WCGF and AH. WCGF fed at 25% diet dry matter may provide sufficient roughage in steam-flaked corn finishing diets.

Key Words: Wet Corn Gluten Feed, Roughage Level, Digestibility

656 Feedlot performance of growing cattle fed four silages with a silage inoculant. M. H. O'Connor*¹, G. M. Hill¹, S. A. Martin², R. N. Gates³, and J. K. Bernard¹, ¹*University of Georgia, Tifton, GA/USA*, ²*University of Georgia, Athens, GA/USA*, ³*USDA-ARS, Tifton, GA/USA*.

Corn (CS), pearl millet (PM), tropical corn (TC), and sorghum (S) silages with (I) or without (NI) SureSorbTM inoculant added at ensiling were compared to determine effects on growing cattle performance. Silages were fed free-choice for 84-d. Dietary energy and CP were adjusted with supplements (SUP) containing rolled corn and soybean meal: SUP-A (27.9% CP, DM basis) fed at 1.25 kg/animal daily with all CS and TC silages; SUP-B (16.2% CP, DM basis) fed at 2.27 kg/animal daily with all PM and S silages. Each SUP delivered Vitamins A, D, and E (24,000, 8,000, and 400 IU/d, respectively), Se (2.0 mg/d) and

lasalocid (150 mg/d). On d 1, steers were implanted with Synovex-S[®], heifers with Synovex-H[®]. Means of consecutive daily full weights were used as initial and final BW. The 10-mo old steers ($n=64$; 282 kg BW) and heifers ($n=64$; 228 kg BW) were ranked by weight and randomly assigned to treatments in a 4 X 2 factorial arrangement. Silage (6 samples/treatment) DM, CP, ADF, NDF, and calculated TDN (%), respectively, were: CS=28.1, 9.3, 25.5, 42.4, 69.8; CSI=29.3, 8.8, 24.3, 41.3, 68.7; PM=21.0, 11.7, 40.0, 59.5, 55.3; PMI=20.8, 12.2, 40.8, 61.2, 56.3; TC=25.9, 8.2, 35.3, 56.8, 66.2; TCI=27.3, 8.2, 35.4, 58.0, 66.0; S=22.2, 7.8, 39.1, 61.4, 56.0; SI=23.6, 7.6, 38.4, 61.3, 55.8. The ADG and DMI (kg), and DM/gain, respectively, by main effects were: Silage=CS, 1.39, 6.97, 5.02; PM, .94, 5.93, 6.37; S=1.16, 6.50, 5.64; TC, 1.07, 6.10, 5.66; SE=ADG, .07, DMI, .05, DM/gain, .14; Inoculant=NI, 1.13, 6.33, 5.71; I, 1.16, 6.41, 5.6; SE=ADG, .05, DMI, .37, DM/gain, .20. Kind of silage affected ADG and DM/gain ($P < 0.01$), and DMI ($P < 0.07$), with highest ADG on CS, lowest on PM, but adding the inoculant did not improve ($P > 0.10$) ADG, DMI or DM/gain in growing cattle.

Key Words: Cattle, Silage, Feedlot

657 Are bacterial direct-fed microbials effective against sub-clinical acidosis in feedlot cattle? G. R. Ghorbani*^{1,2}, D. P. Morgavi¹, K. A. Beauchemin¹, and J. A. Leedle³, ¹*Agriculture and Agri-Food Canada, Lethbridge, AB, T1J 4B1, Canada*, ²*Isfahan University of Technology, Isfahan, Iran*, ³*Chr. Hansen BioSystems, Milwaukee, WI, 53214*.

Sub-clinical acidosis can result in significant economic losses to the feedlot cattle industry. A study was conducted to determine whether bacterial direct-fed microbials (DFM) can be used to minimize the risk of acidosis without compromising the high production levels achieved with high concentrate diets. Six ruminally cannulated steers were used in a double 3 × 3 Latin square to study the effects of DFM on feed intake, ruminal pH, and ruminal and blood characteristics. Steers were provided *ad libitum* access to a diet containing steam-rolled barley, barley silage, and a protein-mineral supplement; 87, 9, and 4% (DM basis), respectively. Treatments were A) *Propionibacterium* P15, B) *Propionibacterium* P15 and *Enterococcus faecium* EF212, and C) control. The bacterial treatments, 10⁹ CFU/g whey powder carrier, or whey powder alone for C, were topdressed once daily at the time of feeding (10g/head/d). Periods consisted of 2 wk of adaptation and 1 wk of measurements, and ruminal pH was measured every 15 min for 6 d using indwelling electrodes. DMI, ruminal pH (mean, minimum, hours pH < 5.8) and blood pH were not affected by treatment ($P > 0.05$). However, treatment A increased ruminal NH₃ concentration ($P < 0.1$) and protozoal numbers ($P < 0.05$) with a concomitant reduction in the number of amylolytic bacteria ($P < 0.05$) compared with the control, while treatment B had no effect. However, it decreased *Streptococcus bovis* enumerated using a selective medium, although this effect was not significant. Although the bacterial DFM used in this study did not induce changes in DMI or ruminal pH, some rumen variables indicated that the propionic acid producing *Propionibacterium* might decrease the risk of acidosis in feedlot cattle.

Key Words: Sub-clinical acidosis, Bacterial direct-fed microbials, Feedlot diet

658 Effect of corn processing on ruminal starch digestion, microbial protein flow, and degradable intake protein requirements of finishing cattle. R. J. Cooper*, C. T. Milton, T. J. Klopfenstein, T. L. Scott, and D. J. Jordon, *University of Nebraska, Lincoln*.

Metabolism and finishing studies were conducted to evaluate the effect of corn processing on ruminal starch digestion, microbial protein flow, and degradable intake protein requirements of finishing cattle. In the metabolism study, six ruminally and duodenally-cannulated steers (523 kg) were used in a replicated 3 × 3 Latin square design experiment. Dietary treatments consisted of 90% concentrate diets that were dry-rolled (DRC), high-moisture (HMC), or steam-flaked corn-based (SFC). True ruminal OM digestibilities were increased ($P < .07$) by approximately 18 and 8% for HMC and SFC, respectively, compared with DRC. Ruminal starch digestibilities were similar between HMC and SFC, but were approximately 19% higher ($P < .05$) compared with DRC. Microbial N flow to the duodenum (g/d) was similar between DRC and SFC; whereas, microbial N flow to the duodenum was approximately 31% higher ($P < .05$) for HMC compared with the average of DRC and

SFC. Microbial N efficiencies were similar among treatments and averaged 25.9 g of microbial N flowing to the duodenum per kg OM truly fermented in the rumen, or 14.4 g of microbial CP per 100 g of total tract OM digestion. In the finishing study, 90 individually-fed steers were fed the same DRC, HMC, and SFC diets as in the metabolism study; however, urea was factored across diets at 0, 0.5, 1.0, or 2.0% of DM. For the dry-rolled corn-based diet, feed efficiency was not improved beyond the first increment of urea, suggesting that the DIP requirement was met at 6.3% of DM. For the high-moisture corn-based diet, nonlinear analysis predicted maximal feed efficiency at 1.14% urea which provided a dietary DIP value of 10.0% of DM. For the steam-flaked corn based diet, nonlinear analysis predicted maximal feed efficiency at 1.64% urea which provided a dietary DIP value of 9.5% of DM. We conclude that degradable intake protein requirements for finishing cattle are increased by corn processing methods that increase ruminal starch digestion compared with dry-rolled corn.

Key Words: Corn Processing, Degradable Intake Protein, Finishing Cattle

659 Factors affecting conjugated linoleic acid production by mixed ruminal bacteria. S. A. Martin^{*1} and T. C. Jenkins², ¹University of Georgia, Athens, GA, ²Clemson University, Clemson, SC.

The objective of this study was to identify environmental factors that influence conjugated linoleic acid (CLA) production by mixed ruminal bacteria. Ruminal contents were collected from a 600-kg ruminally fistulated Hereford steer maintained on pasture. Mixed ruminal bacteria were obtained by differential centrifugation under anaerobic conditions and added to basal medium that contained a commercial emulsified preparation of soybean oil and a mixture of soluble carbohydrates (cellobiose, glucose, maltose, and xylose). Culture samples were collected from batch culture incubations at 0, 2, 4, 6, 8, 12, 24, 26, 28, 30, 32, and 48 h. Continuous culture incubations were conducted at dilution rates of 0.05 and 0.10 per h, extracellular pH values of 5.5 and 6.5, and 0.5 and 1.0 g/L of mixed soluble carbohydrates. Culture samples were obtained from the culture vessel once steady state conditions had been achieved. In batch culture, *trans*-C_{18:1} concentrations increased over time and reached a maximum at 48 h. Little CLA was produced during the first 8 h, but *cis*-9, *trans*-11 CLA concentrations remained high between 24 and 30 h and *trans*-9, *trans*-11 CLA concentrations were high between 24 and 32 h. When mixed ruminal bacteria were maintained in continuous culture on 0.5 g/L of mixed soluble carbohydrates, concentrations of *trans*-C_{18:1}, *cis*-9, *trans*-11 CLA, and *trans*-9, *trans*-11 CLA were reduced ($P < 0.05$) at a dilution rate of 0.05 per h and extracellular pH of 5.5. Similar effects were also observed when 1.0 g/L of mixed soluble carbohydrates was used. When extracellular pH was lowered to 5.0, neither *trans*-C_{18:1} or CLA isomers were detected. In conclusion, our results suggest that culture pH appears to have the greatest influence on the production of *trans*-C_{18:1} and CLA isomers by mixed ruminal bacteria.

Key Words: conjugated linoleic acid, rumen, bacteria

660 Influence of diet on conjugated linoleic acid content of beef. C. S. Poulson^{*}, T. R. Dhiman, D. Cornforth, K. C. Olson, and J. Walters, Department of Animal, Dairy and Veterinary Sciences, Utah State University, Logan, UT 84322-4815.

Conjugated linoleic acid (CLA) has been shown to have health benefits in animal models. Increasing the CLA in beef would enhance its nutritive value. Twenty Angus crossbred steers (235 ± 18.8 kg BW) were used to study the effect of diet on the CLA content of beef. Steers were assigned to one of four treatments in a randomized block design, and were followed from weaning to slaughter. There were two feeding periods (backgrounding and finishing). During backgrounding: Trt 1, 2 and 3 received a diet consisting of a 60:40 forage to grain ratio. Trt 4 received alfalfa hay only. During finishing: Trt 1 and 2 received a diet consisting of a 15:85 forage to grain ratio. In addition to the basal diet Trt 2 received 84 g per head/d of a synthetic mixture of rumen protected CLA isomers. Trt 3 and 4 were finished on pasture containing predominantly Kentucky bluegrass and orchardgrass. Average live BW at slaughter was between 500 to 600 kg. Muscle tissue samples were collected at slaughter from the loin and round of each carcass and analyzed for fatty acid profile. Cattle finished on pasture (Trt 3 and 4) had 275 and 470% more C_{18:1} *trans* fatty acids, respectively, compared with Trt

1 (Table below). C_{18:1} *cis* fatty acids were not different among treatments. Beef from steers raised only on forages (Trt 4) had 550% more CLA (*cis*-9, *trans*-11), whereas steers receiving grain in backgrounding and grazed on pasture during finishing (Trt 3) had 300% more CLA compared with beef from steers fed typical high grain feedlot diet (Trt 1). Supplemental protected CLA (Trt 2) slightly increased CLA in the round, but not the loin. Raising cattle on forages and pasture with no grain supplementation can enhance the CLA content of beef.

Fatty acid*	Muscle	Trt	Trt	Trt	Trt	P <
		1	2	3	4	
C _{18:1} <i>trans</i>	Loin	1.1 ^d	2.6 ^c	3.6 ^b	6.1 ^a	0.03
CLA <i>cis</i> -9, <i>trans</i> -11	Loin	0.19 ^c	0.33 ^c	0.63 ^b	1.06 ^a	0.01
CLA <i>trans</i> -10, <i>cis</i> -12	Loin	0.014	0.053	0.010	0.034	NS
C _{18:1} <i>trans</i>	Round	0.74 ^c	1.54 ^c	3.09 ^b	4.12 ^a	0.02
CLA <i>cis</i> -9, <i>trans</i> -11	Round	0.20 ^d	0.42 ^c	0.97 ^b	1.57 ^a	0.03
CLA <i>trans</i> -10, <i>cis</i> -12	Round	0.012 ^b	0.063 ^a	0.033 ^{ab}	0.046 ^{ab}	0.04

*Mean values shown are as a % of total fatty acids.

Key Words: Beef, CLA, Pasture

661 Effect of corn silage and soybean oil on *in vitro* production of conjugated linoleic acid (CLA) and 18:1 fatty acids by beef finishing diets. K. E. Griswold^{*}, G. A. Appgar, B. N. Jacobson, E. D. Frantz, R. A. Robinson, and J. S. Ely, Southern Illinois University, Carbondale, IL.

A study was conducted to determine the effect of level of corn silage (CS) and soy oil (SO) on *in vitro* production of CLA with beef finishing diets. The experimental design was a 2x3x5 factorial randomized complete block with CS (20 vs. 40% of diet DM), SO (0, 4, or 8% of diet DM) and time (0, 6, 12, 24, and 48 h) as the factors. There four replicates per treatment, and the experiment was conducted twice. Following standard *in vitro* digestibility procedures, incubated samples were analyzed for NDF digestion and fatty acid composition. Fatty acid analysis was performed on fatty acid methyl esters (FAMES) formed by direct acidic methylation. FAMES were quantified by gas-liquid chromatography. The CLA isomers measured were *cis*-9, *trans*-11 (c9,t11), *trans*-9, *trans*-11 (t9,t11), and *cis*-10,*trans*-12 (c10,t12). Total CLA (TCLA) and total 18:1 fatty acids (18:1FA) were also measured. Fatty acid concentrations are reported as mg per g of DM contents. NDF digestion was significantly less when CS was increased from 20 to 40% of diet DM ($P < .05$), and when 8% SO was added compared with 0 or 4% added SO ($P < .05$). Level of SO significantly increased production of t9,t11, TCLA and 18:1FA ($P < .001$), and there was a trend for level to increase c10,t12 ($P = .0725$). Level of CS tended to increase c9,t11 production ($P = .0759$). There was a significant CS by SO interaction for t9,t11, TCLA and 18:1FA ($P < .02$). Time significantly affected c9,t11, t9,t11 and 18:1FA production ($P < .05$) with the greatest concentrations occurring at 12 h of incubation. There was a trend for TCLA concentrations to be affected by time ($P = .0883$) with the greatest concentrations occurring with the 24 h incubation. Both CS and SO can be used to alter CLA and 18:1 fatty acid production during *in vitro* fermentation.

Key Words: CLA, In Vitro, Rumen Biohydrogenation

662 Effects of flake density of high oil corn and typical corn on performance and carcass characteristics of feedlot steers. T. C. Bramble¹, K. F. Wilson^{*1}, C. R. Richardson¹, C. P. Bridge¹, and F. N. Owens², ¹Texas Tech University, Lubbock, ²Du Pont Specialty Grains, Des Moines, IA.

To determine if density of steam-flaked high oil corn (HO) or typical corn (T) affected feedlot performance and carcass composition of feedlot steers, 16 English x Continental crossbred steers (BW = 363 ± 10.6 kg) were fed diets containing corn steam-flaked at either .31 kg/L (24 lb/bu) or .36 kg/L (28 lb/bu) flake densities for 127 d. Prior to initiation of the study steers were fed T processed at .36 kg/L. On d 0, steers were randomly allotted to four dietary treatments: typical corn, .31 kg/L (T24); typical corn, .36 kg/L (T28); high oil corn, .31 kg/L (HO24); or high oil corn, .36 kg/L (HO28). Diets, designed to meet or exceed NRC (1996) requirements, were formulated to be isocaloric and isonitrogenous by including HO into the diet at 75% of DM while T was included at 72% of diet DM with 2.8% blended vegetable and animal fat added to produce diets equal in ether extract. Daily gain of steers was greater ($P = .07$) d 0 to 28 for steers fed HO24 than for steers fed

HO28 and was greater ($P < .05$) from d 0 to 56 for steers fed HO24 than steers fed T24. Neither corn type nor degree of processing affected ($P > .10$) DMI. Feed efficiency (FE) over the total trial was superior ($P > .05$) for HO24 as compared to T24 and HO28. From d 0 to 56, feeding HO24 produced greater ($P < .01$) FE than feeding T24, T28, or HO28. Carcass characteristics (hot carcass weight, internal fat, external fat, marbling score, longissimus muscle area) were unaffected ($P > .10$) by dietary treatments. Differences in carcass variables were not expected because diets were formulated to be isocaloric and isonitrogenous. High oil corn can effectively replace typical corn plus supplemental fat in feedlot diets, and more extensive processing of high oil corn will enhance its feeding value.

Key Words: High oil corn, Steam-flaked corn, Steers

663 Effect of Dry-Rolled High-Oil Corn or Added Corn Oil on Ruminant and Total Tract Digestibility of Beef Cattle Finishing Diets. L.R. Kennington^{*1}, C.W. Hunt¹, J.G. Andrae¹, G.T. Pritchard¹, and F.N. Owens², ¹University of Idaho, Moscow, ²Dupont Specialty Grains, Des Moines, IA.

Three ruminally and duodenally cannulated Angus steers were used in a replicated 3 x 3 Latin square design to evaluate digestion characteristics of dry-rolled high-oil corn and its isogenic counterpart in finishing diets. Dietary treatments included: 1) isogenic typical corn (TC, 79.2% of diet DM), 2) a high-oil corn hybrid (HOC, 79.2% of diet DM), and 3) TC with 2.4% added corn oil (OIL, 76.9% typical corn). Ruminant OM and GE digestibilities were greater ($P < .05$) for HOC and OIL than for TC (66.2, 70.9 vs. 60.2%; 63.5, 67.2 vs. 54.9%, respectively). In contrast, total tract OM digestibility was greater ($P < .05$) for TC and OIL diets than for the HOC diet (88.4, 89.2 vs. 86.9%). Total tract GE digestibility was greater ($P < .05$) for OIL (88.1%) than HOC (85.8%) with GE digestibility of TYP being intermediate (87.2%). Ruminant starch digestibility was greater ($P < .05$) for OIL than TC or HOC (86.1 vs. 75.5 and 78.9%) while total tract starch digestibility was greater for OIL and TC ($P < .05$) than HOC (97.1, 96.3 vs. 94.8%). Total fatty acid digestibility was greater ($P < .05$) for HOC and OIL than TC (75.7, 75.2 vs. 68.8%). Due to higher fatty acid intake, steers fed HOC and OIL had greater ($P < .05$) daily intake of ME (DE^{*.82}) than steers fed TC (32.1, 32.6 vs/ 30.6 Mcal/d). However, diet ME (Mcal/kg DM) was greater ($P < .05$) for OIL (3.07) than TC (2.95) with diet ME of HOC being intermediate (3.01). Despite the higher oil content of HOC and its 3.6% greater GE concentration, slightly greater fecal starch and fatty acid losses reduced its ME advantage to only 2.2% over the diet containing typical corn. Subtracting DE contributed by other diet components,

ME content was not significantly greater (2.6% higher) for the rolled high-oil corn than typical corn. In contrast, adding 2.4% corn oil to the diet increased diet GE by 3% and diet ME by 4.2%, due to slight decreases in fecal starch and NDF concentrations.

Key Words: High-oil corn, Beef, Energy

664 Effects of high oil corn and shade on performance of Angus and Bonsmara x Beefmaster feedlot steers. T. C. Bramble^{*1}, C. R. Richardson¹, K. F. Wilson¹, G. V. Pollard¹, C. P. Bridge¹, F. N. Owens², and G. R. Chapman³, ¹Texas Tech University, Lubbock, ²Du Pont Specialty Grains, Des Moines, IA, ³Amarillo, TX.

This experiment was designed to determine if corn source [high oil corn (HO) vs typical corn (T)] would alter performance of finishing steers with or without access to shade in partially slotted floor feedlot pens. Steers of Angus (A) (n=59, BW = 322 ± 2.2 kg) and Bonsmara x Beefmaster (B) (n = 56, BW = 294 ± 2.1 kg) heritage, were fed for 150 d (July 17 to December 13, 2000). Breed was nested within pens and steers were blocked into pens by weight. Treatments included: NST (no shade, typical corn), NSHO (no shade, high oil corn), ST (shade, typical corn), and SHO (shade, high oil corn). Finishing diets, formulated to meet or exceed NRC (1996) requirements, consisted of 77.7% steam-flaked (.36 kg/L, 28 lb/bu) corn (either HO or T), 10% roughage, and protein, vitamin, mineral, and feed additive supplements. Shade structures, black, 80% light-occluding polypropylene cloth fixed 3 m above pens, covered 67% of pen area (9.8 m² of shade/steer). Supplemental shade increased DMI by 6.8% ($P = .05$) during the first 28 d, HO improved ($P = .02$) DMI by 3.2% from d 28 to 56, but neither shade nor diet impacted ($P > .10$) DMI for the total trial. Steers fed HO had greater ($P = .07$) ADG (1.62 vs 1.55 kg) than steers fed T for the total study, but shade had no effect on ADG. Daily gain was greater ($P < .01$) for A than B cattle over the total trial. Feed efficiency (FE) was improved ($P = .04$) by shades from d 28 to 56 but was not different ($P > .10$) for any other period during the trial. High oil corn improved ($P < .01$) FE by 5.8% from d 0 to 85 and improved ($P = .06$) overall FE by 3.0% (5.13 vs 5.29 kg feed/gain). Although Angus steers gained faster than Bonsmara x Beefmaster and substituting high oil corn for typical corn improved ADG and FE, shades failed to improve performance when averaged over the total trial. However, early in the trial or when ambient temperature increased, shade may improve DMI and FE of typical corn.

Key Words: High oil corn, Shade, Bonsmara

ASAS/ADSA Ruminant Nutrition: Protein Nutrition

665 An evaluation of feeding practices associated with milk production and milk composition. C.R. Richardson^{*} and D.A. Christensen, University of Saskatchewan.

The objective of this study was to look for links between feeding management strategies and milk composition on dairy farms near Saskatoon, SK, Canada. Eleven dairy farms that fed a total mixed ration (TMR) and participated in Dairy Herd Improvement (DHI) testing were selected to participate in a 54 d, observational study. Nine farms completed the study. Data collected included dry matter intake (DMI), particle size variation of TMR, times fed per day, bulk tank milk production and weekly milk composition. Milk component production (Kg) and 3.5% fat corrected milk (FCM) were calculated. Analysis was done on TMR for moisture, CP, NDF, ADF, EE, moisture and ash. Herd size ranged from 37 to 197 cows. Milk protein content ranged from 3.10 % to 3.36 %, which differed between farms ($P < 0.05$). Milk fat content ranged from 3.45% to 4.00% ($P < 0.05$). Total milk production and milk per cow was significantly different between farms ($P < 0.05$). DMI ranged from 19.0 to 31.5 Kg per day. Herds with the highest intakes did not always have the highest milk production. Pearson correlations for DMI and milk yield per cow ranged from -0.35 to 0.46. Herds differed in times fed per day and particle size of the TMR. Herds with the highest NDF and ADF were not necessarily the highest fat herds. Small ration particle size was not always highly correlated with milk fat percentage. Strength of correlations for feeding practices varied between farms. Milk production correlated strongly with milk protein yield ($r^2=0.988$) and milk fat yield ($r^2=0.993$). Fluctuations in daily DMI were significant between farms. There are many factors that influence milk production

and composition. It appears that the amount each of these factors contributes varies from farm to farm and includes a combination of feeding management techniques

Key Words: milk composition, feeding management, nutrition

666 Effect of different levels of dietary protein on nitrogen metabolism of heifers. J.C. Marini^{*} and M. E. Van Amburgh, Cornell University, Ithaca NY 14853.

Four Holstein heifers (with an initial weight of 204 kg ± 5 SD) were used in a Youden square design (5 periods and 5 treatments) in order to investigate the effect of dietary protein levels on nitrogen (N) metabolism. Five diets (D) calculated to be isocaloric on a ME basis (30% hay:70% concentrate) varied in CP levels from D1 to D5, 8.9, 12, 15.7, 18.6 and 21.4 %CP respectively, and were fed to the animals at 2x maintenance. Differences in CP were achieved by substituting citrus pulp for soybean meal. Plasma urea nitrogen (PUN) concentration and rumen ammonia concentration (RAN) for D1 and D2 were low and suggested that they were N deficient although only the lowest level of protein intake depressed total tract DM and NDF digestibilities ($P < 0.01$). Nitrogen balance increased with increasing levels of CP although D2 was not statistically different than D3, D4 and D5. Fecal N excretion and the non-urea fraction of urinary N did not differ among treatments. Lucas analysis showed that the true digestibility of the protein was 96% and metabolic fecal N excretion was 0.54 g N/MBW ($R^2=0.99$). Endogenous urinary N was 0.24 g/kg MBW and the N excreted in the urine

accounted for 87% of the N apparently absorbed ($R^2 = 0.97$). The data demonstrate that heifers on a N deficient diet (D2) were able to maintain performance and NDF digestibilities similar to heifers on higher CP diets despite low levels of RAN. It appears the heifers were able to salvage N by reducing urea clearance by the kidney. Creatinine clearance suggests that this was achieved by increasing the tubular reabsorption (TUR) of urea.

	D1	D2	D3	D4	D5	sem	Linear P<
Body weight, kg	267.9	266.7	266.8	269.3	266.4	3.6	0.93
Diet CP,							
% DM	9.0	11.8	15.7	18.6	21.4	0.22	0.01
Diet NDF,							
% DM	33.5	32.7	32.2	31.1	30.5	0.19	0.01
DM intake,							
kg/d	6.0	5.9	5.9	6.0	5.9	0.06	0.97
N intake,							
g/d	87.6	110.5	147.5	178.7	203.5	5.1	0.01
PUN,							
mg/dl	1.7	4.1	9.5	14.0	19.1	1.1	0.01
RAN,							
mg/dl	0.1	2.2	8.4	14.2	26.8	2.0	0.01
NDF dig,							
% NDF	37.2	49.5	49.8	45.9	49.8	1.5	0.01
Fecal N,							
g/d	46.3	49.6	49.2	52.0	50.3	1.2	0.21
Urinary N,							
g/d	21.6	36.1	68.7	94.4	120.8	5.8	0.01
N balance,							
g/d	19.7	24.8	29.6	32.3	32.4	4.0	0.01
Urinary							
Urea N,							
g/d	6.4	14.6	50.0	70.1	101.7	5.6	0.01
Non-Urinary							
Urea N,							
g/d	15.3	21.5	18.7	24.4	19.1	2.6	0.49
Urea							
Clearance,							
ml/min	201.3	291.7	359.8	358.9	365.8	39.6	0.01
TUR,							
%	45.8	27.3	14.2	17.6	3.0	8.5	0.01

Key Words: Nitrogen, urea, endogenous

667 Effect of increasing level of dietary protein on serum concentrations of metabolic hormones and mammary development in Holstein heifers consuming a moderate-energy diet. R. Lopez^{*1}, C.R. Krehbiel², M.G. Thomas¹, D.M. Hallford¹, D.H. Keisler³, B.S. Obeidat¹, J.A. Hernandez¹, W.D. Bryant¹, M. Garcia¹, and R. Flores¹, ¹New Mexico State University, ²Oklahoma State University, ³University of Missouri.

The dietary level of CP and CP:ME dietary ratio could be used as tools to manipulate physiological processes of growth and mammary development and increase lifetime milk production. Herein, 24 Holstein heifers (initial BW = 143–30 kg) 120 d of age were individually fed a 52:48 concentrate:roughage diet (NEm = 1.61 Mcal/kg; NEg = 1.01 Mcal/kg) with increasing levels of protein (12, 14, 16, and 18% CP from Soybean meal [SBM]; DIP=68.5% of CP; n = 6 heifers/protein level) until they reached puberty. After puberty, heifers were slaughtered during the mid-luteal phase of the estrous cycle. Previously, we reported that maximum growth rate was achieved in heifers consuming 16% CP, but levels of 12 to 18% produced adequate growth rates without altering the weight of viscera, liver, peripheral tissue, mammary gland or the age of puberty [J. Anim. Sci. 78 (Suppl. 1): 294]. Further investigation revealed that corporal fat (P = 0.31), mammary parenchymal tissue weight (P = 0.58), parenchymal RNA and DNA (P = 0.24), and the RNA:DNA ratio (P = 0.50) were not affected by treatments. However, heifers consuming 16% CP tended (P = 0.12) to have more total mammary fat than those consuming 12, 14, or 18% CP. Mammary fat masses for 12, 14, 16, and 18% CP diets were 0.65, 0.65, 1.1, 0.64 kg, respectively. No differences were observed in serum concentrations of leptin, GH, or IGF-1 (P ≥ 0.28) across treatments. However, serum concentrations of insulin (P < 0.02) were greatest in heifers consuming diets of 16% CP whereas serum concentrations of glucose were greatest (P < 0.05) in heifers consuming diets of 18% CP. Concentrations of insulin, glucose, and leptin increased (P < 0.05) in heifers as they aged

from 120 to 291–8 d. Uniquely, partial correlation analyses with the effect of treatment removed, revealed that serum concentrations of leptin were positively correlated with mammary fat (r = 0.21, P < 0.05) but negatively correlated with (r = -0.23, P < 0.05) corporal fat. Data provide evidence to suggest that moderate energy diets containing 16% CP from SBM stimulate enhanced growth and mammary adiposity relative to diets containing 12, 14, and 18% CP. These results could be due to alterations in the milieu of metabolic hormones influenced by the diets.

Key Words: Holstein, Mammary, Leptin

668 Increased crude protein to energy ratios on in situ dry matter disappearance, rumen ammonia, nitrogen balance, and urinary excretion of purine derivatives of prepubertal Holstein heifers. M.T. Gabler^{*}, A.J. Heinrichs, and L.C. Griel, *The Pennsylvania State University.*

Four prepubertal Holstein heifers, 1465.0 d of age and 152.87.6 kg of BW, fitted with ruminal cannulae were used to evaluate dietary crude protein (CP) to metabolizable energy (ME) ratio's (g CP: Mcal ME) influence on in situ DM disappearance (DMD), rumen ammonia (RA), N excretion (NE), and urinary excretion of purine derivatives in a 4X4 Latin square design with 21 d periods. The diet's CP:ME ratios were 45:1, 63:1, 69:1, and 77:1 g of CP per Mcal of ME. The CP:ME ratios were altered by adjusting the concentration of CP (11.9, 16.7, 18.1, and 20.1 % CP) with similar amounts of ME (2.6 Mcal/kg) across all diets. Diets contained corn silage and grass hay as forage sources with a protein pellet and supplemental soybean meal as the protein sources. Diets were formulated to provide a 60:40 forage to concentrate ratio, and were fed once daily at 2.0 % BW DMI. In situ DMD increased quadratically (P<0.01) for the ratio 63:1 CP:ME and was 8 % and 14 % greater than the 77:1 and 45:1 CP:ME ratios respectively. A linear increase (P<0.01) was observed for RA and blood urea nitrogen as CP:ME ratios increased. A linear increase (P<0.01) in urinary N excretion resulted in a linear increase (P<0.01) in total NE as CP:ME ratios increased. Nitrogen utilization tended to improve quadratically (P=0.17) with the ratio 63:1 CP:ME which showed a 41 %, 14 %, and 20 % greater N retained as a % N consumed than the 77:1, 69:1, and 45:1 CP:ME ratios, respectively. Urinary excretion of the purine derivative allantoin increased linearly (P=0.02) with increasing CP:ME ratios. Feeding a CP:ME ratio of 63:1 at 2% BW DMI has comparable performance with higher CP:ME ratios, but results in greater N retained as a % of N intake.

Key Words: Heifer, Rumen, Protein to Energy Ratios

669 Degradation of soluble crude protein in the rumen. M. Melin¹, M. Gierus^{*1}, A.M. van Vuuren¹, and G.A.L. Meijer¹, ¹ID TNO Animal Nutrition.

Although CP in the soluble fraction lost during washing of nylon bags is often assumed to be fully and rapidly degraded in the rumen, its actual fate in the rumen is questioned. We developed a filtration procedure that mimics machine washing of nylon bags and enables a further characterization of this soluble fraction. The filtrate of 1-3 g of DM of ten feeds was collected in 100 ml of rinsing water. Feeds were two grass silages (GS1, 25% of DM, and GS2, 53% of DM), wet brewers grain silage (WBGS) and corn gluten feed silage (CGFS), 3 types of corn gluten feed (CGF1 to 3), soybean meal (SBM), lupine meal (LPM) and rape seed meal (RSM). DM and N losses of the filtration procedure and machine washing were compared in quadruplet samples. DM losses during filtration and from nylon bags ranged from 16% in WBGS to 46% in GS1 and were not different between procedures. N recovered in the filtrate ranged from 11.5% for SBM to 56.1% for GS1. The filtrate was centrifuged at 1500 g for 20 min. The pellet was analyzed for N in non-soluble particles (NS). Soluble true proteins (TP) in the supernatant were precipitated with TCA (10% in the final volume), and the N in the remaining supernatant was defined as non-protein N (NPN). The NS fraction comprised 0% (GS1 and 2) to 87% (WBGS) of N in the filtrate. Significant amounts of TP were found in SBM (53%), LPM (30%) and RSM (27%). NPN ranged from 13% (WBGS) to 100% (GS1 and 2) of N in the filtrate. The degradation of the protein N (NS +TP) in the filtrate of 6 feeds was measured in rumen fluid using a modified Broderick method. After 4h of incubation the percentages of degraded protein were: 0% (WBGS and CGFS), 24% (CGF 2), 55% (RSM), 79% (LPM) and 80% (SBM). These results show that CP in the soluble fraction, as determined in the nylon bag technique, consists of different protein and non-protein fractions, that are not always rapidly and fully degraded

in the rumen. The potential underestimation of the protein value of these feeds, calculated as $((NS + TP) / N_{feed}) \times \% \text{undegraded}^{4h}$, is 2 - 7 % for the concentrates, and 13 % and 26 % for CGFS and WBGS, respectively.

Key Words: Soluble protein, Degradability, Dairy Cattle

670 Effects of varying dietary protein and fiber levels on the production of lactating dairy cows. G. A. Broderick*, U.S. Dairy Forage Research Center, Madison, WI.

Eighteen primiparous and 45 multiparous Holstein cows were blocked by parity and DIM and randomly assigned to 7 squares in an incomplete Latin square trial with 4, 4-wk periods. Nine TMR, 3 levels of NDF each at 3 levels of CP, were formulated from alfalfa and corn silages, high moisture corn, solvent soybean meal, plus minerals and vitamins. Levels averaged (DM basis) 36, 32 and 28% NDF and 15.1, 16.7 and 18.4% CP. Milk yield and DMI were measured daily in the last 2 wk of each period; yield of milk components was determined one day in each of the last 2 wk of each period. Fecal and urine grab samples were collected in the last wk of each period to estimate N excretion. The statistical model included square, cow(square), period(square), CP and NDF level, and 2-way interactions; the error term was cow(square). No 2-way interactions or quadratic effects were significant ($P \geq 0.21$) (data not shown). There were linear increases in DMI, MUN and urinary N excretion, and linear decreases in milk N/N intake (NI) and fecal N excretion, with increasing dietary CP. There were linear increases in BW gain, yield of milk and milk components and milk/DMI, and linear decreases in MUN, milk N/NI and urinary N excretion, with decreasing dietary NDF. Reducing dietary NDF improved milk yield and efficiency; increasing dietary CP from 15.1 to 18.4% had little effect on yield but reduced N utilization.

Trait	CP, % of DM			NDF, % of DM			Linear ¹		
	15.1	16.8	18.4	36	32	28	SE	CP	NDF
DMI, kg/d	21.1	22.3	22.6	21.7	22.1	22.1	0.2	0.03	0.84
BW gain, kg/d	0.44	0.57	0.55	0.39	0.47	0.71	0.13	0.76	0.02
Milk, kg/d	32.8	34.6	34.4	31.4	33.8	36.5	0.4	0.48	<0.01
Fat, kg/d	1.15	1.24	1.20	1.20	1.24	1.15	0.03	0.33	0.48
Protein, kg/d	0.98	1.03	1.02	0.92	1.01	1.10	0.02	0.46	<0.01
SNF, kg/d	2.95	3.06	3.06	2.78	3.01	3.28	0.05	0.62	<0.01
MUN, mg/dL	9.2	12.4	16.0	13.3	12.7	11.5	0.2	<0.01	<0.01
Milk/DMI	1.56	1.55	1.52	1.45	1.53	1.65	0.02	0.35	<0.01
Milk N/NI	0.31	0.28	0.25	0.26	0.27	0.30	0.01	<0.01	<0.01
Urinary N/NI	0.23	0.28	0.34	0.31	0.29	0.26	0.01	<0.01	0.06
Fecal N/NI	0.45	0.44	0.41	0.44	0.44	0.44	0.01	<0.01	0.37

¹Probability of linear contrasts.

Key Words: Dietary protein, Dietary fiber, Milk yield

671 The effect on milk production of a ruminal nitrogen (N) deficiency in dairy cows: evaluation of the Cornell Net Carbohydrate and Protein System (CNCPS) ruminal N deficiency adjustment. R. Ruiz*, L. O. Tedeschi, and D. G. Fox, Cornell University, Ithaca, NY.

Twenty-four multiparous and fifteen first lactation Holstein cows averaging 263 days in milk and 614 kg of body weight (BW) were fed ruminal N deficient or adequate diets, based on predictions of the CNCPS. After adjustment to a low CP TMR (11% CP) the cows were allocated in 13 blocks based on milk production, body condition score, and BW. Within each block, cows were randomly assigned to one of the 3 treatment (TRT) diets (8, 10 and 13% CP for TRT 1, 2, and 3 respectively). All diets contained the same proportion of high moisture corn, chopped grass hay, and minerals, with urea substituted for corn silage as needed to reach the 3 CP levels. The TRT diets were then fed for 4 wk. Feed samples were composited weekly and analyzed for NDF, lignin, CP, soluble protein, NPN, NDFN, ADFN, fat, and ash. Carbohydrate degradation kinetics were determined on the corn silage and hay samples. The least squares means for ruminal N balance (% of required) predicted by the CNCPS differed ($P < .0001$) among the 3 TRT; values were 92.3, 108.2, and 132.3% for TRT 1, 2, and 3 respectively. Milk production was significantly affected by TRT; milk production increased as ruminal N balance increased. TRT affected DMI; however, no significant differences were found between TRT 2 and 3. Plasma urea nitrogen (PUN) concentration differed among the 3 TRT diets. CNCPS predictions (with

and without the N deficient adjustment) of metabolizable protein (MP) allowable milk production were compared to observed milk production. Using individual weekly cow data from all 3 TRT, the CNCPS accounted for 69 and 72% of the variation in MP allowable milk without and with the N deficient adjustment, respectively.

	TRT 1	TRT 2	TRT 3	SE
Milk, kg/d	15.5 ^a	18.8 ^b	21.7 ^c	1.14
Fat, %	3.67 ^a	4.18 ^b	4.10 ^b	0.12
Protein, %	3.32 ^a	3.52 ^b	3.56 ^b	0.08
DMI, kg/d	17.6 ^a	20.0 ^b	21.2 ^b	0.79
PUN, mg/dl	2.5 ^a	4.5 ^b	11.6 ^c	0.27

Values within rows with different superscripts differ ($P < 0.05$)

Key Words: Ruminal nitrogen deficiency, CNCPS

672 Effect of dietary carbohydrate composition on utilization of ruminal ammonia nitrogen for milk protein synthesis in dairy cows. A. N. Hristov* and J. K. Ropp, Department of Animal and Veterinary Sci., University of Idaho, Moscow, ID 83844-2330.

A trial with four ruminally and duodenally cannulated, late-lactation dairy cows (32319.5 DIM; 26.81.65 FCM) was conducted to investigate the effect of dietary carbohydrate (CHO) composition on ruminal ammonia N utilization and transfer into milk protein. Two diets were fed three times a day, at 8-h intervals in a cross-over design. The diets (RFSS and RFNDF) were formulated to provide similar levels of undegradable and soluble protein and total ruminally fermentable CHO but differed in the composition of the CHO fractions: diet RFSS contained a larger proportion of available CHO in the sugars and starch fractions (barley and molasses) and diet RFNDF contained a larger proportion in the ruminally fermentable NDF fraction (corn, beet pulp, and brewers grains). Nitrogen-15 was used to label ruminal ammonia N and consequently the microbial and milk N pools. Diet RFNDF resulted in a lower (trend at $P < 0.1$) proportion of bacterial N derived from ruminal ammonia N (36.6%) as compared to diet RFSS (61.8%). The proportion of milk protein N originating from ruminal microbial N (based on the areas under the ¹⁵N-enrichment curves) was higher ($P < 0.001$) on the RFNDF diet as compared to the RFSS diet (44.0 and 29.4%, respectively). The proportion of milk protein-N originating from ruminal ammonia-N was not different ($P > 0.05$) between the two diets (18.7 and 16.4%, diets RFSS and RFNDF, respectively). The milk urea N concentration varied greatly with time of sampling and individual cows and was lower ($P < 0.05$) with the RFNDF than with the RFSS diet (13.9 and 16.1 mg/dl, respectively). The results from this study suggested that, compared to diets containing higher levels of ruminally fermentable starch and sugars, diets providing higher concentration of ruminally fermentable NDF can enhance the transfer of ruminal microbial N into milk protein. The overall level of utilization of ruminal ammonia-N for milk protein synthesis was not affected by the CHO composition of the diets.

Key Words: Dairy Cows, Rumen Ammonia, Milk Protein

673 Evaluation of models to predict urinary excretion and milk urea nitrogen. R.A. Kohn*¹, K.F. Kalscheur², and E. Russek-Cohen¹, ¹University of Maryland, College Park, ²South Dakota State University, Brookings.

Milk urea nitrogen (MUN) has been used to estimate urinary nitrogen (N) excretion and identify overfeeding or underfeeding of protein to dairy cows. Urinary N (g/d) was first reported to equal 12.54 times MUN (mg/dl), but recently was reported to equal 17.64 times MUN. In September of 1998, the National Dairy Herd Improvement Association (DHIA) revised the methods for developing calibration standards for MUN analyses. As a result, MUN values reported by DHIA labs decreased from previous values by an undetermined amount. The objectives of this research were 1) to evaluate models that predict urinary N and expected MUN, and 2) to quantify changes that occurred in the fall of 1998 in MUN analyses performed by DHIA. Two data sets were used. The first was from the spring of 1998 (n=92) and the second was from the spring of 1999 (n=12). The lack of fit of the models to the data was represented as the root mean square prediction error (RM-SPE) which includes error due to bias and dispersion. For the older data set, the newer model underestimated ($P < 0.01$) MUN by an average 3.8 mg/dl (RMSPE = 4.9), while the older model was accurate (RMSPE =

4.3). However, for the newer data set, the older model overestimated ($P < 0.01$) MUN by 4.8 mg/dl (RMSPE = 6.2), while the newer model was accurate (RMSPE = 3.0). MUN measurements were compared for the two data sets after adjusting for differences in milk production, feed intake, and body weight. In the period between the two studies, MUN values appeared to decrease by an average of 4.0 mg/dl, thus changing coefficients to predict urinary N and target MUN concentrations. Using the recent data set, urinary N (g/d) was equal to MUN (mg/dl) times 16.2 (SE=0.85) for Holstein cows averaging 623 kg in body weight. Changes in the MUN values reported by DHIA labs have resulted in target MUN concentrations changing from 12 to 16 mg/dl to a current target range of 8 to 12 mg/dl for most Holstein herds.

Key Words: Milk urea nitrogen, Urinary nitrogen

674 Effect of diet and sampling technique on milk allantoin. W.M. Schager*, J.H. Harrison, and D. Davidson, Washington State University, Puyallup, WA USA.

Two experiments were conducted on dairy cows to determine the effect of: 1) a diet change on the temporal change in milk allantoin output, and 2) techniques for collecting milk samples for allantoin determinations. In experiment one, 4 lactating Holstein cows were used in a 2 x 2 Latin square design with 2 treatments and 2 periods. Treatments were the ratio of forage to concentrate (40:60 and 60:40) and periods were 5 days. Milk samples were collected twice daily for 20 consecutive milkings and analyzed for milk allantoin. Milk yield and dry matter intakes were also recorded. In experiment two, milk from 6 Holstein cows was collected at 1030 h by: 1) a strip sample collected immediately before milking, 2) a strip sample collected 3 minutes from start of milking, and 3) a composite sample taken with an autosampler. Milk yield, milking time, and milk allantoin concentration were recorded for each cow. In experiment one, there was a significant ($P < 0.02$) change in the amount of allantoin in milk 12 h (first subsequent milking) after a change in diet. There was no difference in milk yield or dry matter intake between treatments. In experiment two, no difference was detected in milk allantoin concentration among the three sampling methods. In conclusion, a temporal change in milk allantoin amount can be observed within 12 h after a diet change. Strip samples of milk taken immediately before milking may be an alternative to collecting composite milk samples for the analysis of milk allantoin.

Table 1. Forage to Concentrate Ratio

Milk	40:60	60:40	SE
Allantoin (mmol/milking)	7.49 ^a	6.51 ^b	0.09

Table 2. Milk Sampling

Milk	Pre strip	Mid strip	Composite	SE
Allantoin (mg/ml)	83.0	86.0	83.8	3.52

^{a,b} $P < 0.02$

Key Words: Allantoin, Dairy, Milk

675 Protein quantity and quality for dairy cows exposed to hot, humid weather. J. W. West*¹, J. K. Bernard¹, D. S. Trammell¹, P. S. Chan¹, and J. M. Fernandez², ¹University of Georgia, Tifton, GA/USA, ²LSU Agricultural Center, Baton Rouge, LA/USA.

Twenty lactating Holstein cows averaging 103.3 DIM (± 37.5 d) were used in an 11 wk trial to determine the response to dietary CP and RUP concentrations fed during hot weather. The study duration was May 10 through July 25. Mean maximum and minimum temperature, relative humidity, and temperature-humidity index (THI) were 32.6 and 20.6°C; 89 and 42%; and 80.9 and 69.1. Treatments were arranged as a 2 x 2 factorial to provide 17.0 or 18.5% CP and 33.6 or 41.1% RUP using Prolak[®] as the RUP source. Intake of DM, milk yield, 3.5% FCM yield, and FCM per DMI for moderate and high CP and moderate and high RUP diets were: 22.7, 23.7, 23.2, 23.2 kg/d; 28.3, 31.5, 30.3, 29.4 kg/d; 31.3, 35.3, 33.4, 33.2 kg/d, and 1.37, 1.45, 1.41, 1.42 kg/kg. No significant main effects or interaction were detected ($P > .10$). Milk fat and protein percentages, fat and protein yields, and milk urea N for

moderate and high CP and moderate and high RUP diets were: 4.04, 3.91, 4.05, 3.91%; 2.89, 2.82, 2.92, 2.80%, 1.17, 1.28, 1.24, 1.22 kg/d, 0.83, 0.91, 0.88, 0.87 kg/d, 11.1, 13.2, 11.8, 12.5 mg/dl. There was a CP by RUP interaction for fat yield ($P < .07$), and MUN was higher for the high CP diet ($P < .03$). Respiratory rate was not different by treatment, but was elevated (79.1 breaths/min). Concentrations of triiodothyronine (T3), thyroxine, cortisol, insulin, glucose, and serum urea N for moderate and high CP and moderate and high RUP diets were: 117.42, 102.43, 118.64, 101.20 ng/dl, 3.30, 3.40, 3.52, 3.17 μ g/dl, 1.05, 1.02, 1.10, .97 μ g/dl, 9.33, 10.73, 9.86, 10.19 μ IU/ml, 3.03, 3.07, 3.09, 3.01 mmol/L, and 5.10, 6.17, 5.47, 5.80 mmol/L. Significant effects for CP and RUP on T3 concentration ($P < .06$ and $P < .03$, respectively), and for CP on serum urea N content ($P < .001$) were detected. There was a trend for improved milk and FCM yield with high CP, but no effect with RUP supplementation. It appears that the moderate levels of CP and RUP were adequate to maintain production under the hot, humid conditions of the study.

Key Words: Heat stress, Protein, Rumen undegraded protein

676 Effect of condensed tannins on proteolytic bacterial populations in the rumen and on nitrogen flow to the abomasum of sheep. B.R. Min*¹, G.T. Attwood², W.C. McNabb², and T.N. Barry³, ¹E (Kika) de la Garza Institute for Goat Research, Langston, ²AgResearch, Grassland Research Center, Palm/North, NZ, ³Massey university, Palm/North, NZ.

Twelve six month old sheep (33 ± 2.3 kg BW) were fed *Lotus corniculatus* (32g condensed tannins (CT)/kg DM) to examine effects of CT on four proteolytic rumen bacterial populations and nitrogen (N) flux to the abomasum (Ab). In Experiment 1, the populations of rumen bacteria were enumerated directly from rumen samples using a competitive polymerase chain reaction technique. In Experiment 2, ruminal N flux in whole rumen digesta was measured by continuous infusion of ¹⁵N ammonium chloride into the rumen of all sheep. Effects of CT were determined by making measurements in the presence and absence (CT-acting) of polyethylene glycol (PEG), which binds and inactivates CT. When feeding perennial ryegrass/white clover (referred to as pasture), populations of *Clostridium proteoclasticum* B316, *Eubacterium* sp. C12b, *Streptococcus bovis* B315, *Butyrivibrio fibrisolvens* C211a were 1.6×10^8 , 2.7×10^8 , 7.1×10^6 and 1.2×10^6 per ml, respectively. When the diet was changed from pasture to Lotus, the average populations of same strains from the same animals decreased significantly ($P < .001$) to 5.1×10^7 , 1.5×10^8 , 2.6×10^6 and 1.0×10^6 per ml, respectively. When PEG was infused into the rumen of sheep fed Lotus, the populations of proteolytic bacteria increased significantly ($P < .01-.001$) compared with the CT-acting group. The N and DM intake, rumen non-ammonia N (NAN) and microbial NAN (MNAN) pool sizes, and abomasal MNAN flux were similar in both groups. However, CT reduced ruminal N digestibility and ammonia pool size ($P < .05-.01$), and increased the flow of non-MNAN to the Ab ($P < .01$). Lotus CT protected protein against degradation in the rumen, and increased the flow of by-pass protein to the Ab. Therefore, more protein was available for hydrolysis in the small intestine in sheep fed Lotus.

Key Words: Bacterial population, N flux

677 Multiple regression analysis of data collected across many trials: a meta-analytic approach. N.R. St-Pierre*, The Ohio State University.

There are frequent reports of statistical analyses done on data collected across many studies published in scientific literature. Generally, standard multiple regression analysis procedures are used. There are two fundamental reasons why such methods are inappropriate in these instances. First, observations within a study have more in common than observations across studies. Ignoring the study effect in the analysis leads to inflated and biased estimates of the residual variance. Second, levels of the independent variables are not pre-planned and, generally, are very imbalanced. Ignoring the study effect leads to biased estimates of regression coefficients. We illustrate the proper meta-analytic procedure using two regression analyses published in the 2001 Nutrient Requirements of Dairy Cattle publication (table 5-3). The regression involved 206 observation means from 38 studies. Using conventional multiple regression methods, the milk response (M, kg/d) to dry matter intake (I, kg/d), rumen undegradable protein (U, % of DM), and rumen degradable protein (D, % of DM) was: $M = -52.6$ (SE=10.2) + 1.10

(SE=0.11) I + 8.66 (SE=1.74) D + 1.52 (SE=0.24) U + 0.35 (SE=0.08) D² with an estimated residual variance of 22.6. A mixed model with the same fixed effects but also with the random effect of study yielded the following equation: M = -17.2 (SE=7.5) + 1.42 (SE=0.09) I + 2.31 (SE=1.23) D + 0.95 (SE=0.17) U + 0.09 (SE=0.05) D² with an estimated residual variance of 6.59. A more complete mixed model resulted in an estimated residual variance of 5.70. The marginal milk production response to R and D must account for the marginal effect of R and D on I derived by fitting the following mixed model also with the ran-

dom effect of *study*: I = 18.1 (SE=1.26) + 0.16 (SE=0.08) D + 0.14 (SE=0.07) U. In a second example of the response in milk production to I and crude protein level in the diet, mixed models methods again reduced the estimated residual variance and generated better estimates of regression coefficients. Using the proper meta-analytic methods resulted in more accurate and precise estimates of production responses to nutrient concentrations in the diet.

Key Words: Meta-analysis, Multiple regression, Milk production response

ASAS/ADSA Teaching Undergraduate and Graduate Education and PSA Extension and Instruction: Teaching II

678 NASA's Reduced Gravity Student Flight Opportunities Program enhances undergraduate experiences and promotes team-building skills. S.T. Willard*¹, ¹*Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State, MS.*

A proposal was submitted to NASA's Reduced Gravity Student Flight Opportunities Program (RGSFOP) by 9 undergraduate animal science majors and their advisor. The RGSFOP provides a unique academic experience for students to propose, design, fabricate, fly and evaluate a reduced-gravity experiment of their design. The overall experience includes scientific research, traditional and non-traditional classroom experiences and educational/public outreach activities. Of the 87 applications submitted, 47 proposals were accepted (54%) including the proposal from the Mississippi State Team. The aim of the proposed project entitled "Photonic Emission Kinetics of the Firefly Luciferase Enzyme in Microgravity" was to determine whether enzymatic reactions are altered in microgravity. The students met weekly to design the experiments and learn about working in microgravity. The team then traveled to the Johnson Space Center (Houston, TX) where for two weeks they participated in astronaut training, learned about NASA programs and tested their experiments. The students then flew aboard the Boeing KC-135A reduced gravity trainer aircraft to conduct their experiments during the 20 or more 25-second Zero-gravity maneuvers on each of two flights. Results indicated that there was a significant increase (P < .05) in the area under the enzyme reaction curve; illustrating that microgravity altered luciferase kinetics. Upon returning home, students participated in outreach activities including television, radio and newspaper interviews and presentations at departmental, alumni and other university functions. The students also constructed a web-site detailing their activities and continued to meet weekly to discuss their experiences. In addition to learning about scientific research and NASA, the students also learned the foundations of NASA Mission Operations: discipline, competence, confidence, responsibility, toughness and teamwork. In terms of lasting outcomes, the participating students commented that this experience was life-changing for many of them. This was re-enforced by comments from many of their professors indicating a positive change in student attitudes and confidence. In summary, the NASA RGSFOP offers both a unique research and personal growth experience for undergraduate students.

Key Words: Undergraduate education, NASA, Microgravity

679 Engaging students in the learning process in an undergraduate animal breeding course. G. E. Shook* and D. L. Thomas, *University of Wisconsin-Madison.*

An active learning approach that utilized short lectures, in-class discussions, and written feedback from students was applied to an undergraduate animal breeding course. The approach is based on a textbook that meets course goals in breadth and depth of content. The textbook and special readings, not lectures, define the scope of the course. The course is organized into two-period modules. Each module relates to a specific assignment that students are expected to read before class. Students take a 10-min quiz over the reading assignment at the start of the first period of a module before there is any in-class coverage of the material. The quiz tests for broad understanding rather than mastery of the material and rewards students that have read the assignment. The last question on the quiz is, "What is the most difficult or unclear concept in the chapter?" A 25-min lecture on the important points of the reading follows. For the final 15 min, students are given a discussion question that gives application to the material or reinforces concepts. Groups of 2 to 4 students are formed, and the group writes down their response. Several groups are asked to reveal results of their deliberations, and

the instructor comments on the accuracy and applicability of their comments. The second period starts with a 35-min lecture that addresses the concepts that the students indicated on the quiz were most difficult for them and finishes with another 15-min discussion question. Each module has a homework assignment that provides practice with application of concepts presented in the module. With this overall approach, students come to class familiar with the material to be discussed, attend class (something is completed in class and graded every period), have some control in directing the lecture to areas they are less sure about, and learn from the experiences of their classmates during the discussion periods. Students are active participants in their learning, and instructors are well informed by frequent feedback from students. Student comments include: "The organization of the class, homework and quizzes made me keep up with the material." "The discussions are an absolute must." "Discussion took up too much time in class." "This class requires self-teaching."

Key Words: Active learning, Animal breeding, Teaching

680 Research Proposal Writing and Student Peer Panel Evaluation as an Instructional Component for a Microbiology Graduate Course in Poultry Science. I.B. Zabala Diaz*, X. Li, and S.C. Ricke, *Texas A&M University, College Station, Texas/USA .*

Proposal writing is a vital experience for Poultry Science graduate students seeking academic careers, but graduate programs provide minimal opportunities to develop successful proposal writing skills. Proposal writing is emphasized in a graduate microbiology course taught in the Poultry Science Department, Texas A&M University. Based on a survey of enrolled students in the year 2000, only 28.5% of the students had previous experience in class proposal writing, but none possessed experience in proposal writing for funding. In addition, 71 % of the students had some experience at scientific writing but less than 30% had published scientific papers. The proposals for the course were written on a research problem that utilized information and concepts from the course and included a student peer panel evaluation as part of the course grade. The proposals were judged on the clarity of hypothesis presentation, the appropriateness of the experimental approaches and research relevance in basic and applied science. Overall, students found the experience an important one for developing writing skills in scientific style. However, peer panel evaluation received a mixed response as students found it difficult to understand proposals that fell out of their area of study (21%) and had little preparation in order to offer constructive criticism of other proposals (43%). Based on survey responses of students (36%), it is apparent that further improvement in the student peer panel evaluation needs to be made to increase the relevance of this exercise. In conclusion, proposal writing and in-class evaluation as part of a graduate course in Poultry Science provided graduate students with additional writing and communication skills required for future careers in research.

Key Words: Proposal writing, Communication skills, Peer panel evaluation

681 Evaluation of student performance in an introductory animal science course by pre-test and post-test scores. T. L. Perkins* and R. J. Andreasen, *Southwest Missouri State University, Springfield, Missouri.*

AGS 101 is an introductory course emphasizing farm animal industries, breeds, numbers, distribution, nutrition, heredity, reproduction, health, and products. Students enrolling in this introductory course come from a wide range of diverse backgrounds and experiences. In addition, this

course, AGS 101 is a general education requirement for all agriculture majors at Southwest Missouri State University. A pre-test examination containing 29 multiple choice questions was given to all students enrolled in each of six sections over the past three years. The same examination was utilized at the end of the semester to assess the knowledge level of each student. Information was additionally gathered concerning major, class rank, gender, FFA background, GPA, and final course grade. Initial data results point to a significant increase in scores from pre-test ($\mu = 38\%$) to post-test ($\mu = 59\%$) examinations. Highest pre-test scores were found on dairy specific questions (63%) and equine specific questions (48%). Highest post-test scores were found on genetics specific questions (73%) and dairy specific questions (67%). Area specific questions indicated students improved (pre- vs post-test) from highest to lowest as follows: 1) genetics (29%), 2) reproduction (25.7), 3) beef (25.5%), 4) meats (23.6%), 5) nutrition (23%), 6) sheep (19%), 7) horse (11%) and 8) dairy (4%). Generally, students who indicated previous high school FFA experience had a higher mean pre-test score than did students without high school FFA experience. Likewise students indicating animal science or pre-veterinary science as their major scored higher on the initial pre-test examination. While the mean post-test examination score improved in all classes, students without previous high school FFA experience improved their post-test examination scores by a greater percentage. A similar relationship was noted for animal science and pre-veterinary science majors as compared to other departmental majors.

Key Words: Pre-test, FFA, Examination

682 Assessment of student learning in animal science programs: how do we know that they know? R. C. Rhodes III*, *University of Rhode Island.*

Assessment, a key element in accountability and accreditation, is a process that has been widely incorporated into the strategic plans of academic organizations with a goal of improving institutional effectiveness. As education is the primary endeavor of academic institutions, focus of assessment efforts has typically been on the processes of teaching and learning. However, the dilemma faced by many academic units including departments of animal science is the "what" and "how" of assessment. What should our students know when they graduate from our programs? How do we assess what they know? What evidence is available that animal science students have great depth of understanding in their subject area? The key to success of an assessment effort is the clear articulation of what we want students to know. Hence, we must define in broad terms, the objectives of our animal science programs. Equally imperative is the definition of desired, specific academic outcomes. Once objectives and outcomes are established, evidence is then collected to document outcomes. Importantly, a variety of outcome indicators should be used in the assessment of student learning in the animal sciences. Examples of outcome indicators include: capstone experiences (e.g., senior thesis, internships, directed or independent research studies), portfolios (e.g., a compendium of papers written by a student in conjunction with reflections on writing), standardized tests (e.g., GRE), locally developed tests (e.g., a department-generated exit examination), professional licensing or certification (e.g., ARPAS certification), grade point average, graduation rates, job placements, graduate school acceptances, professional school acceptances, employer surveys, etc. For successful completion of the assessment, outcome data is evaluated and, afterward if needed, academic objectives and outcomes are revised. The assessment process should benefit all stakeholders: improved learning by students; shared purpose and focus of faculty and reaccreditation of the institution for administrators are all tangible endpoints. Ultimately, assessment is meant to be a continuous process that leads to improvement of institutional effectiveness.

Key Words: Assessment, Student, Learning

683 Utilizing a group project to teach principles of reproductive management. G. A. Perry* and M. F. Smith, *University of Missouri, Columbia, MO.*

Reproductive Management (senior level course; ~40 to 50 students/semester) students at the University of Missouri are required to develop a detailed plan for improving reproductive efficiency in a beef herd over a 5 yr period. The objectives of this exercise are to: 1) improve reproductive efficiency through implementation of reproductive management principles, 2) integrate economic principles of reproductive

management, and 3) understand the constraints of different geographical locations on approaches to reproductive management. Groups of 3 to 4 students are provided with the reproductive and economic records of a farm/ranch at different locations within North America. Students create reproductive management plans consisting of 1) detailed discussion of farm/ranch environment (climate, terrain, forage and grain availability, and stocking rate; season for breeding and calving; and justification for choice of breed), 2) assessment of current level of reproductive performance, 3) identification and economic justification of specific (measurable) objectives, 4) discussion of alternatives for accomplishing specific objectives, 5) prediction of reproductive performance (pregnancy rate, pounds of calf weaned per cow exposed, and cost per pound of calf weaned) in response to implementation of specific management practices, and 6) an annual reproductive and economic summary. Students obtain livestock marketing information for their assigned location via the Internet. Excel spreadsheets were developed to calculate the reproductive efficiency of postpartum cows and replacement heifers based on the groups' management decisions as well as a yearly economic summary for each of the 5 yr. Management decisions are justified in a written report, and oral presentations are given to the class upon completion of the project. Greater than 80% of students indicate that this exercise increased their understanding of how management decisions affect the reproductive efficiency and profitability in a beef operation and gave them added confidence as they apply for beef management positions.

Key Words: Reproductive Management, Problem Solving, Group Project

684 Dairy Challenge: A competitive and educational experience in evaluation of dairy herd management. L.E. Davis*¹, F.M. Martsolf², J.J. Domecq¹, and M.S. Weber¹, ¹*Michigan State University, East Lansing,* ²*Cargill Animal Nutrition, Mentone, IN.*

The Dairy Challenge event allows students to apply knowledge gained in the classroom by competitively evaluating the management practices of commercial dairy farms. Michigan State University, with the generous support of Cargill Animal Nutrition, has implemented the annual program in the Department of Animal Science. Participants in the Dairy Challenge will do the following: 1) critically evaluate dairy herd management practices and make recommendations for improvements; 2) visit local farms and gain knowledge of different farms' management practices; 3) interact with company representatives from the industry, and increase their understanding of the role of companies in the dairy industry; 4) evaluate herd records, and gain knowledge in PC-DART and computer presentation tools; and 5) improve speaking, presentation, and problem-solving skills. Teams of three or four undergraduate students consist of second-year Agriculture Technology and/or upper level students in the four-year program in the College of Agriculture and Natural Resources. Students critically evaluate a commercial dairy farm using herd records from the past year, a description of the farm, and a tour of the facilities. The farmer and the herd's nutrition consultant answer questions pertaining to management of the farm. Teams give a 30-minute presentation that is scored on their description and assessment of the management practices and recommendations for improvements in facilities and management. Additionally, scoring is based on apparent level of preparation, speaking, presentation skills, and responses to questions asked by judges. The judges for this event are university and dairy industry specialists, including a dairy extension agent, nutrition consultant, dairy business specialist, technical service specialist, and the farm manager. This event allows students to interact with dairy farmers and representatives from the dairy industry, and challenges the knowledge and skills gained by the students during their academic career.

Key Words: Dairy Management, Teaching, Evaluation

685 Extended supplementation of limiting amino acids to increase effective dietary protein and improve production of heat stressed broilers. A. J. Zarate*¹, E. T. Moran, Jr.¹, and D. J. Burnham², ¹*Poultry Science Department, Auburn University, Auburn, AL 36849*, ²*Heartland Lysine Inc. Chicago, IL 60631*.

Broilers in a hot environment decrease their feed intake and growth. Uric acid formation from amino acids in excess of optimal balance generates heat. Presumably, adding limiting essential amino acids (EAA) beyond requirement levels but proportioned for total balance enables an increase in effective protein which could compensate for reduced feed intake while decreasing heat generation. A total of 400 male and 400 female broilers Ross x Avian 24K was reared sex separate to 7 weeks of age in 32 floor pens. A commercial type feeding regimen was fed either "as is" or supplemented with limiting EAA to assure at least 110% of the requirements that approximated an ideal pattern. Environmental conditions existing from May-June were sufficiently hot to depress performance but not cause related deaths. Increasing the levels of EAA and balance within existing crude protein and ME did alter live performance throughout experimentation. Measurement of abdominal fat after birds were processed indicated a significant increase with the carcasses of both sexes when the 110% level of EAA was employed. Carcass yield without abdominal fat, incidence of grade defects, and recovery of deboned breast meat were similar between treatments, respective of sex. Improved amount and balance of effective protein together with reduced excretion of N likely increased dietary productive energy with its conversion to depot fat, but no advantage to live performance was perceived.

Key Words: Broilers, Carcass Characteristics, Heat Stress, Limiting Essential Amino Acids.

686 Reduced lysine and threonine levels in a phase-feeding regimen can support maximum growth performance during the grower phase. J.A. Townsend*, H.R. Pope, and J.L. Emmert, *University of Arkansas*.

Phase-feeding (PF) has been explored as a means of reducing feed costs without reducing growth performance. Predicted amino acid requirements for PF are generated using linear regression equations derived from estimates of lysine (Lys), sulfur amino acid (SAA) and threonine (Thr) requirements. The objective of this study was to determine if growth performance would be impacted by reduced levels of lysine and threonine in a PF regimen relative to birds fed NRC recommendations. In addition to NRC (Treatment 1) and unmodified PF (Treatment 2) regimens, four modified PF treatments were tested. In two modified PF treatments, predicted Lys (Treatment 3) and Thr (Treatment 5) requirements were reduced by 10%, whereas in the remaining modified PF treatments the slopes of the linear regression equations used to predict Lys (Treatment 4) and Thr (Treatment 6) requirements were increased by 15%. The six dietary treatments were administered from 3-6 weeks of age. The NRC diet was fed throughout the entire experiment, whereas treatments 2, 3, 4, 5 and 6 were tested in a series of 3 diets (21-28, 28-35, and 35-42 d). Despite a reduction in Lys and Thr levels in treatments 3, 4, 5 and 6, no differences ($P > 0.05$) in weight gain, feed intake and feed efficiency were detected among treatments at 42 d. Relative to treatments 1 and 2, digestible Lys intake was reduced ($P < 0.05$) by treatment 3 and digestible Thr intake was reduced ($P < 0.05$) by treatments 5 and 6. Breast yield was not reduced ($P > 0.05$) in treatments 3, 4, 5 and 6 relative to treatments 1 or 2, however abdominal fat percentage was increased ($P < 0.05$) by treatment 3. These data indicate that despite a substantial reduction in Lys and Thr levels, growth performance of birds fed these PF regimens was not different than birds fed NRC recommendations. Because dietary Lys, SAA, and Thr levels are decreased under PF systems, substantial dietary cost savings may be available.

Key Words: Broiler, Phase-feeding, Amino Acids

687 Evaluation of Amino Acid Dose-Response Data and Implications for Commercial Formulation of Broiler Diets. D. Hoehler*, S. Mack, and M. Pack, *Degussa-Huels Corporation, Kennesaw, GA*.

Many of the performance indicators of a modern integrated broiler enterprise, such as feed cost per ton, serve to de-link the operation into

discrete business units. This disintegrative management does not necessarily lead to the best overall profit. In the present study, case scenarios are drafted for two different production goals minimum feed cost per kg live weight gain or minimum feed cost per kg breast meat, which comprise the whole production chain. The amino acids lysine and Met+Cys are used as variable factors, because their dietary concentration has a large effect on several efficiency measures of an integrated operation. Actual performance data of 9 dose-response experiments for Met+Cys and another 5 with lysine were combined with cost figures for feed and supplemented amino acids. Data covered the grower/finisher period of commercial broiler strains. The relative response in performance between the lowest and highest levels of lysine or Met+Cys was similar, which offered the opportunity to pool all dose-response data after transforming them to a relative scale. Data were then subjected to exponential regression analysis. The best performance as described by the maximum of the regression curve was set at 100%. Subsequently, relative performance data were transformed back to absolute values by setting the desired optimum performance at 100%. Under the given conditions, feed cost per kg live weight gain reached a minimum at dietary concentrations of 0.90% Met+Cys and 1.03% lysine. The response in feed cost per kg breast meat to rising amino acid levels is not only affected by the feed to gain ratio, but also by the increasing breast meat yield as percentage of live weight. This extra benefit shifted the optimum dietary Met+Cys and lysine concentration to 0.98% and 1.16%, respectively. Price changes for raw materials or amino acids only slightly shifted the economic optimum level for the respective amino acid. This approach may well be extended to other nutrients and can serve as a general tool to determine dietary specifications in a meaningful way.

Key Words: Broiler, Dose-Response, Economics

688 Growth and carcass response of male broilers to two commercial sources of supplemental L-lysine. ME Jackson*¹, A Lemme¹, JL Emmert², and HR Pope², ¹*Degussa Huls Corporation, Kennesaw GA*, ²*University of Arkansas, Fayetteville, AR*.

Biolys[®] 60 is a new form of lysine containing 47.3% L-lysine (46.8% free plus 0.5% protein-bound L-lysine) plus additional energy and nutrients from the biomass, including 0.2% phosphorus, 0.3% Met+Cys, 0.5% Thr, and 0.15% Trp. Biolys[®] 60 is produced by microbial fermentation of *Corynebacterium glutamicum*, and the lysine substitution value is calculated as 60% of the value of L-lysine-HCl. A 49-d floor pen trial with 1890 male Ross X Cobb broilers, 54 floor pens, and 35 birds/pen was conducted to determine responses to 2 forms of supplemental lysine. Starter and grower series of corn/soybean meal/corn gluten meal-based diets were provided from 0-21 and 22-49d. Nine isonitrogenous dietary treatments (x 6 replicates) included a non-supplemented control and 4 levels of added lysine from the 2 sources. Starter and grower basal diets contained 20.72 and 17.56% CP and 0.83 and 0.62% Lys, respectively. L-lysine was added at 0.08, 0.16, 0.24% and (0.42% starter, 0.30% grower) from each source. Birds responded to both lysine sources with 0-49 d gain ranging from 1466 g (no supplementation) to 2811 g (highest supplementations) ($P < 0.01$), feed:gain ratio (FCR) decreasing from 3.10 to 2.10 ($P < 0.01$), and breast yield increasing from 17 to 27% of carcass weight ($P < 0.01$). Experimental data were subjected to non-linear exponential regression analysis. This permits the evaluation of the complete response curve to graded levels of a limiting amino acid. The data fitted well to predicted values with r-square values ranging from 0.90 to 0.99 for the measured criteria. The calculated relative effectiveness of Biolys[®] 60 compared to L-lysine-HCl was 110 and 104% for weight gain and breast yield, respectively. Both values were not significantly different from 100%. It is concluded that Biolys[®] 60 is at least equal to L-lysine-HCl in eliciting performance responses in broiler chickens.

Key Words: Lysine Sources, Broilers, Breast Yield

689 Interaction of methionine and lysine in broiler diets changed at NRC or industry time intervals. M. B. Cafe*, C. A. Fritts, and P. W. Waldroup, *University of Arkansas*.

The broiler industry changes feed at intervals that differ from those on which NRC requirements are based. A study was conducted to examine the response of broilers to diets formulated to contain different levels of Lys and Met when diets were changed at intervals on which NRC recommendations are made (0 to 21 d for starter; 21 to 42 d for

grower; 42 to 49 d for finisher) as compared to intervals used by the poultry industry (0 to 16 d for starter; 16 to 35 d for grower; 35 to 49 d for finisher). Diets were formulated to provide a minimum of 110% of essential amino acids (NRC) other than Met or Lys; these were formulated to be at 100% of NRC recommendations. Aliquots of a common basal diet were fortified with DL-methionine and lysine HCl to provide a factorial arrangement with three Met levels (100, 115, 130% of NRC) and four Lys levels (100, 110, 120, 130% of NRC). These were fed at either NRC feed change intervals or at industry feed change intervals for a total of 24 treatments. Each treatment was fed to four pens of 60 male broilers in litter floor pens. At 35, 42, and 49 d samples of birds were processed to determine dressing percentage (DP) and breast meat yield (BY). Changing at NRC intervals resulted in significantly higher BW and better FCR at 21 and 42 d but not at 35 or 49 d. Birds fed diets changed at NRC intervals had significantly greater BY at 42 and 49 d. However there were no interactions between time of change and either Met or Lys levels for any factor. Birds fed diets with 110% of Lys were significantly superior to those fed 100% Lys in virtually every category. Increasing levels of Met also improved performance in nearly every category. However, there were few interactions between Lys and Met levels. Results of the study suggest that more attention be paid to needs of these amino acids when dietary feeding programs are altered.

Key Words: Broilers, Diet Change, Amino acids

690 Ileal true digestibility of protein does not increase with age in broiler chicks. E.L. Miller*, Y.X. Huang, O.C. Fabb, B. Rayner, and S. Kasinathan, *Department of Clinical Veterinary Medicine, University of Cambridge.*

Endogenous N (EN) loss and ileal true digestibility of fish meal (FM) and soybean meal (SBM) were determined at 4, 7, 11 and 14 days of age. Six diets contained 144, 185 and 226 g crude protein (CP)/kg supplied by FM or SBM as the sole protein. A further diet (EHC) contained 211g CP/kg from enzyme-hydrolysed casein supplemented with amino acids to determine EN. Chromic oxide was used as marker. From 350 day old male broiler chicks (Ross) 96 chicks weighing (SD) 492.4g were randomised to 24 cages each with 4 chicks. The FM and SBM diets were each randomised to 3 replicate cages while EHC was randomised to 6 cages. The remaining chicks were reared on commercial chick starter crumb until 4, 7 or 11 days of age when 72 chicks of average weight 80.5, 154.14, 18315.3g were allocated at 3 birds per cage to 3 replicates of each test diet and 6 replicates of EHC. Test diets were offered for 3 or 4 days ad libitum, fasted overnight and then killed by intra-peritoneal injection with sodium pentobarbitone 4 h after the re-introduction of food. Ileal digesta was washed from the ileum (vitelline junction to 1 cm from the ileo-caecal junction) freeze-dried, pooled per cage and analysed for N and Cr. Ileal digesta from EHC was centrifuged over a 10,000 dalton membrane before drying. EN (mg N/g diet) determined with EHC and by regression to zero FM or SBM (including EHC as zero FM or SBM) did not change with age (meanSEM, EHC 1.350.146, 1.030.085, 0.960.166, 1.140.103; regression with FM 1.380.255, 1.030.230, 1.050.248, 1.160.178; regression with SBM 1.290.175, 0.94.0.154, 0.970.289, 1.120.160 at 4, 7, 11, 14 d). Ileal true digestibility, calculated from the regression of ileal N/g diet on diet N/g diet including EHC as zero test N, did not differ with age with FM (0.910.011, 0.890.010, 0.900.011, 0.910.008 at 4, 7, 11, 14 d) but with SBM d 4 (0.950.008) was greater than d 7 (0.920.007) or d 11 (0.910.013) (P<0.05) but not d 14 (0.930.007). EN and ileal true digestibility of FM or SBM N did not increase with age.

Key Words: Ileal Digestibility, Endogenous , Age

691 Effects of supplemental antibiotics in a diet containing sub-optimal protein, methionine and lysine on the performance, carcass characteristics and organ measurements of finishing broilers reared under hot-humid climate. A. A. Onifade*¹, A. A. Odunsi², S.G. Ademola^{1,2}, and B.R. Olorede³, ¹Department of Animal Science, University of Ibadan, ²Department of Animal Production and Health, Ladoke Akintola University of Technology, Ogbomoso, ³Department of Animal Production and Health, Usmanu Danfodiyo University, Sokoto, Nigeria.

Protein and amino acid requirements of broilers decrease with age; therefore, finishing broilers may be economically and environmentally friendly raised on lower protein and critical amino acid concentrations. However, maximization of performance and reduction of carcass fat in broiler fed

low-protein diet critically deserve research attention, and we hypothesized that supplemental dietary antibiotics might be useful. 5-week old broilers were fed for 4 weeks on diets containing 16% crude protein (CP) and 80% of the recommended methionine and lysine without or with penicillin, streptomycin, tylosin, and zinc bacitracin added separately at 75 mg kg⁻¹ or control diets containing 18% or 20% CP and adequate amino acids. Antibiotic-fed broilers enhanced (P<0.05) their feed intakes; feed conversion correlated with dietary CP and was similar in all broilers fed 16% CP. The body weights, carcass and breast yields of antibiotic-fed broilers were heavier (P<0.05) than those fed unsupplemented diet, compared with those fed 18% CP, but lower than those fed the 20% CP. Abdominal fat of antibiotic-fed broilers was smaller (P<0.05) than those fed unsupplemented 16 and 20% CP, which were inexplicably similar. Antibiotic-fed broilers had bigger (P<0.05) lymphoid organs: spleen and bursa of fabricious; lengthier (P<0.05) intestines and smaller (P<0.05) gizzards than broilers fed unsupplemented 16% CP though gizzard weights were generally heavier on all the 16% groups irrespective of the supplements. The implication of the comparable productive indices obtained on low-protein antibiotic-fed broilers suggests improved, economical and environmentally friendly feeding program with feasible adoption in finishing broiler nutrition barring no restrictions to antibiotic use in animal feeds.

Key Words: Supplemental Antibiotics, Sub-optimal Dietary Protein and Amino Acids, Finishing Broilers

692 Influence of heat processing of corn and barley and enzyme supplementation on nutrient digestibility of broiler chicks. M. I. Gracia*, M. J. Aranibar, and G. G. Mateos, *Universidad Politecnica de Madrid. Spain.*

A trial was conducted to study the influence of heat processing (HP) of cereals, and enzyme supplementation (ES) on digestibility of nutrients of broilers from 0 to 21d. There were 8 treatments arranged factorially, with two basal cereals (corn vs barley), two processing treatments (raw vs cooked for 1h at 103°C and 19% moisture), and two levels of ES (0 vs 500ppm). The enzyme complex contained 20,000 TLXU of xylanases, 90 BAU of α -amylases, and 19,000 PU of proteases per kg. Each treatment was replicated 5 times (16 Cobb chicks per cage). The apparent fecal digestibility (AFD) of organic matter (OM), crude protein (CP), ether extract (EE), and neutral detergent fiber (NDF) was measured at 4, 8, 15, and 21d of age. Digestibility of nutrients varied with time for all treatments (P<0.05). Heat processing improved AFD of OM, CP, and NDF until 8d of age (58.6 vs 62.1 %, 45.5 vs 47.6 %, and 22.6 vs 27.5 %, respectively; P<0.05), but not thereafter. However, HP increased AFD of EE throughout the trial (58.4 vs 64.3 %; P<0.05). Also, HP increased AFD of NDF in barley but not in corn diets (P<0.01), while the opposite occurred for EE (P<0.01). Birds fed barley had lower digestibility coefficient of OM at 8 and 15d (P<0.05) than broilers fed corn diets, but the differences disappeared thereafter. On the other hand, AFD of EE was greater for barley than for corn diets throughout the trial (P<0.01). Enzyme supplementation improved AFD of OM, CP and EE for all diets throughout the trial (61.3 vs 64.0 %, 46.7 vs 51.1 %, and 58.9 vs 63.7 %, respectively; P<0.05) but the effect was greater for barley than for corn diets (P<0.05). Enzyme supplementation improved AFD of EE more for HP than for raw cereal diets (P=0.05). It is concluded that nutrient digestibility of broiler chicks was modified by both HP and ES though the beneficial effects of HP were only noticed during the first week of age, and the effect of ES was greater for barley than for corn diets.

Key Words: Heat Processing, Digestibility, Broilers

693 Age and dietary influences on size and fermentation patterns in the gastrointestinal tract (GIT) of broilers fed wheat and corn diets. E. N. Fischer*¹, H. L. Classen¹, and M. Choct², ¹University of Saskatchewan, Saskatoon, SK Canada, ²University of New England, Armidale, NSW, Australia.

An experiment was conducted to identify changes in size and bacterial fermentation patterns in broilers (840) fed diets containing corn (C), wheat (W) or wheat supplemented with endoxylanase (E, Avizyme 1300, 0.1%). Birds were sampled for GIT measures and contents were collected weekly for viscosity and volatile fatty acid (VFA) determination. Jejunal viscosity was highest (p≤0.05) for the W treatment (trt) at all ages except 7d. Ileal viscosity was highest in this diet at all ages. Empty jejunal and ileal weights and ileal length were higher (p≤0.05) for W and E trts relative to the C trt at most ages. Jejunal content

weight also trended higher for W and E trts at most ages ($p \leq 0.001$, 35d). Ileal content weights were highest ($p \leq 0.05$, 7d) from birds on the W trt to 21d, after which both W and E trts yielded higher content weights than C ($p \leq 0.05$, 35d). Empty caecal weights were highest ($p \leq 0.05$, 14, 21, 35d; $p \leq 0.10$, 42d) from birds on the E trt, while content weights from this trt trended highest to 21d only. Ileal VFAs were not affected by trt and levels peaked at 14d and declined thereafter. Caecal VFAs from all trts increased steadily to 28d, then declined. Acetate and butyrate accounted for the greatest proportion of total VFAs and were both highest ($p \leq 0.05$) in birds from the W and E trts at 21d, when ileal viscosity peaked. Caecal propionate ($p \leq 0.05$) and isovalerate ($p \leq 0.10$) levels were highest in birds from the C trt at all ages except 7d. The higher NSP content of the wheat diets likely caused the increased GIT size of the W and E trts. While the NSP in W and E trts are broken down by the caecal bacteria to acetate and butyrate, the C trt resulted in the production of propionate and isovalerate. The latter finding suggests that undigested starch and protein from corn enter the caeca and are being fermented by bacteria in this location.

Key Words: Non-starch polysaccharides, Volatile fatty acids, Bacterial fermentation

694 Live performance, caloric efficiency, carcass characteristics, and cost/gain of broiler chickens fed corn-soy-poultry byproduct diets with or without the enzyme Rovabio Excel™. M.D. Sims*¹, M. Blair², and D. M. Hooge³, ¹Virginia Scientific Research, Inc., Harrisonburg, VA, ²Aventis Animal Nutrition, Alpharetta, GA, ³Hooge Consulting Service, Inc., Eagle Mountain, UT.

Two floor pen trials were conducted to evaluate and compare the performance, caloric efficiency and carcass characteristics of broilers fed diets with or without Rovabio Excel™ enzyme (RX). Custom starter, grower and finisher corn-soy based diets containing a level of 4% poultry by-product meal were used in each trial. The studies were similar except for dates the tests were conducted and broiler strain crosses used. In trial 1, 2,880 Ross x Ross 308 and in trial 2, 2,880 Ross x Arbor Acres broilers were used. Two series of basal diets, differing by 66 kcal ME/kg within each trial and identified as regular energy (RegME) and lower energy (LowME) diets, were used. Calculated ME levels of RegME feeds ranged from 3030 to 3251 kcal/kg, and LowME feeds ranged from 2964 to 3185 kcal/kg. Crude protein levels were adjusted proportionally with energy. The liquid form of RX was used in these trials and was sprayed on RegME and LowME pelleted feeds at 200 ml/metric ton. Live weights, feed conversion, caloric efficiency, mortality and carcass characteristic data were pooled after no significant treatments x experiment interactions were found. Pooled wk 3 live weight of the LowME + RX group tended to be heavier ($p=0.11$) than the LowME group. Combined wk 7 live weight of the RegME + RX group was significantly heavier ($p=0.02$) than the RegME group. Pooled wk 3 feed conversion ratio was significantly lower ($p=0.03$) for the LowME + RX group than the LowME group. Caloric efficiency (adjusted to a common weight) of the LowME + RX group was significantly better ($p < 0.001$) than its LowME control (6,184 kcal/kg vs. 6,425 kcal/kg, respectively). Deboned breast of the RegME + RX and LowME + RX groups were heavier ($p < 0.01$ and $p=0.06$, respectively) than those of their respective control groups. Feed expense per kg gained was lower ($p \leq 0.05$) for the LowME + RX group than for the LowME group (0.2899 dollars vs. 0.2961 dollars, respectively) but similar ($p \geq 0.05$) between the two RegME groups (0.2961 dollars vs. 0.2959 dollars). Broilers benefited from the addition of RX to diets with either RegME or LowME but most prominently when applied to LowME diets with calculated ME in the range of 2964 to 3185 kcal/kg.

Key Words: Broilers, Rovabio Excel™, Caloric efficiency

695 The effect of barley concentration, Natugrain blend 66%L and Natugrain 33%L on performance of broilers fed wheat-based diets. M.B. Coelho¹, B.W. Cousins¹, W.F. McKnight*¹, P. Blanchard¹, A. Knox², and J. McNab², ¹BASF, ²Roslin Nutrition Ltd.

Three thousand eight hundred and forty, day old broilers were utilized in a 4X3 factorial design (8 reps/treatment) to determine the effect of barley concentration (0, 10, 20 and 30%), and enzyme (0, Natugrain® Blend 66%L at 150 ppm, and Natugrain® 33%L at 300 ppm) on the performance of broilers fed wheat-based diets. The starter phase diets were

fed in crumble form and growing-finishing phase diets were fed in pellet form. Eighteen-day performance of 0% barley diets for enzyme treatments 0 enzyme, Natugrain Blend and Natugrain were: weight gain, g (624^d, 587^{abc} and 585^{abc}), FCR (1.412^{ab}, 1.422^{ab}, 1.456^{ab}), viscosity, cps (2.912^a, 5.242^c, 7.009^d). Eighteen-day performance of 20% barley diets for enzyme treatments 0 enzyme, Natugrain Blend and Natugrain were: weight gain, g (603^{cd}, 592^{abc} and 580^{abc}), FCR (1.454^{ab}, 1.428^{ab}, 1.479^{ab}), viscosity, cps (3.981^b, 6.297^d, 6.584^d). Increasing levels of barley decreased performance. However, NSP enzyme addition compensated for the negative performance effect of barley.

Key Words: Broilers, NSP enzymes, Diet composition

696 Improved utilization of wheat screening by enzyme supplementation. B.A. Slominski*¹, D. Boros¹, W. Guenter¹, L.D. Campbell¹, and O. Jones², ¹University of Manitoba, Winnipeg, MB, Canada, ²Canadian Bio-Systems Inc., Calgary, AB, Canada.

Research conducted in our laboratory has shown positive attributes associated with wheat screenings. In comparison to wheat, wheat screenings were found to contain less starch (44.8 vs 56%, as fed basis), similar amounts of sugars (1.4 vs 1.2%) and NSP (9.9 vs 9.1%) and significantly more protein (15.0 vs 12.6) and fat (6.4 vs 1.2%). The latter two components contributed to good performance of broiler chickens (2 week growth trial) fed wheat-based diets substituted with wheat screenings. A significant improvement in animal performance was also noted with enzyme supplementation. To further substantiate the importance of enzyme supplementation, a long-term production trial with broiler chickens was conducted. Five replicate pens of 60 birds per treatment were used in starter (21 days) and grower (16 days) phases of the experiment consisting of three treatments: positive control (PC)(wheat/soybean meal/fish meal), negative control (NC)(wheat/wheat screenings/barley/soybean/canola meal) and NC+Enzyme. In comparison to PC, the NC diet contained 10% less metabolizable energy, crude protein, amino acids and calcium and 25% less available phosphorus. The enzyme supplement included xylanase, glucanase, cellulase, phytase and a broad spectrum of other enzyme activities. Body weight gain and feed conversion ratio averaged 2.14, 2.10, 2.17 kg/bird and 1.68, 1.76, 1.66 for PC, NC and NC+Enzyme, respectively. A significant ($P < 0.05$) improvement in broiler chicken performance with enzyme supplementation was further substantiated by the same magnitude of difference in dry matter (71.2, 68.7, 75.1%), energy (AME)(2956, 2827, 3066 kcal/kg), starch (92.5, 90.3, 95.6%), NSP (4.8, 15.0, 36.1%) and phytate (44.3, 37.5, 69.5%) digestibilities. It is evident from this study that the use of wheat screenings in concert with an effective enzyme supplement will allow for cost effective formulation of poultry diets.

Key Words: Wheat screenings, Nutritive value, Broiler chicken, Enzyme

697 Apparent metabolizable energy of drought tolerant barley cultivars as affected by enzyme supplementation. G. W. Barbour*¹, A. H. Darwish¹, M. T. Farran², N.N. Usayan³, M. M. Beck⁴, H. H. Machlab¹, M. G. Uwayjan², and V. M. Ashkarian², ¹Agriculture Research Institute, Tel Amara, Beqa'a, Lebanon, ²American University of Beirut, Beirut, Lebanon, ³Lebanese University, Beirut, Lebanon, ⁴University of Nebraska, Lincoln, Nebraska.

A chick assay was conducted to study the effect of enzyme supplementation on AME and AME_n of three drought tolerant barley cultivars 'Litani' (L), 'Pamir-35' (P), and 'Rihane-03' (R). A reference diet containing 55% glucose was prepared. Corn, L, P, and R replaced 50% glucose in the experimental diets with 0 or 0.1% Avizyme 1100®. Each diet was fed to 4-d-old Arbor Acres male broiler chicks in four replicates with four birds per replicate. Total fecal collection was made 48 and 96 h post 7-d adaptation period. Soluble non-starch polysaccharide concentration in L, P, R, and corn grains was 5.83, 2.56, 4.86, and 1.36%, while total β-glucan content was 3.91, 4.32, 3.56, and 0.04% DM, respectively. The AME and AME_n of corn were 4034 and 3944 kcal/kg DM, respectively. There was no significant interaction between barley cultivar and enzyme level. Also no significant cultivar effect was detected and the overall means across enzyme levels of AME were 3226, 3164, and 3191 kcal/kg DM, while those of AME_n were 3094, 3083, and 3088 kcal/kg DM for L, P, and R, respectively. Enzyme addition, however, increased ($P < 0.05$) AME and AME_n means across barley cultivars by

283 and 304 kcal/kg DM, respectively. In conclusion L, P, and R barley cultivars had similar ME values which were improved through enzyme supplementation.

Key Words: Barley cultivars, Enzyme, Apparent metabolizable energy

698 ME-equivalent value of feed enzymes varies with dietary nutrient concentrations for broilers. Keying Zhang*, Shaoqun Zuo, Zhiyong Ni, and Daiwen Chen, *Institute of Animal Nutrition, Sichuan Agricultural University, Yaan, Sichuan 625014, PR. China.*

ME-equivalent value (MEV) of feed enzymes is important for the formulation of diets supplemented with enzymes. Whether MEV of an enzyme product is constant or varies with dietary nutrient concentrations (DNC) is not yet known. In this study, a two-factor D-saturated optimization regression design with six treatments was used to measure MEV of a complex feed enzyme product (CFE) in the diets of various DNC for broilers. CFE consisted of amylase (2400U/g), beta-amylase (20000U/g), beta-glucanase (5800U/g), protease (3800U/g), cellulase (1700U/g), xylanase (4600U/g) and pectinase (55000U/g). Basal diet

PSA Nutrition: Early Nutrition, Immunology, and G. I. Function

699 Effect of fasting versus feeding Oasis[®] after hatching on nutrient utilization in chicks. A.B. Batal* and C.M. Parsons, *University of Illinois, Urbana, IL USA.*

Two experiments were conducted to determine the effects of fasting, feeding OasisTM, or feeding a corn-soybean meal (SBM) diet immediately after hatching on growth performance, and energy and amino acid utilization of chicks. In each experiment, six pens of eight chicks were assigned to four treatments which were feeding a corn-SBM diet for 21 d immediately after hatching, fasting for 48 h (no feed or water) after hatching, or feeding OasisTM for 24 or 48 h after hatching. The fasting and feeding OasisTM treatments were followed by feeding the corn-SBM diet for 21 d. Excreta were collected at 0-2, 3-4, 7, 14, and 21 d on feed for determination of MEn and amino acid digestibility. Fasting chicks for 48 h posthatching significantly depressed weight gains compared to all other treatments at 21 d of age. Although weight gains were not significantly different at 48 h posthatching, chicks fed OasisTM for 48 h had significantly ($P < 0.05$) higher weight gains at 1, 2, and 3 wk of age than did chicks fasted for 48 h. As days on feed increased from three to 21, energy utilization (ME_n) increased for all the experimental treatments. In addition, the ME_n of the corn-SBM diet for chicks fed OasisTM for 24 and 48 h was significantly ($P < 0.05$) higher than for chicks fasted for 48 h at most ages. There were generally no large differences in ME_n values among other dietary treatments within ages. Digestibility of most amino acids increased with increasing age for all experimental treatments, and the digestibility values were similar among treatments. Our results indicated that feeding OasisTM (compared to fasting) had a beneficial effect on subsequent energy utilization of a corn-SBM diet and that OasisTM may be stimulating early gut development even though early growth (0-48 h) is not affected.

Key Words: OasisTM, Age, Chicks

700 The effect of mannanoligosaccharides, bambarmycins, and virginiamycin on the physical and microbial characteristics of the gastrointestinal tract of large white male turkeys. C. W. Parks*, J. L. Grimes, and P. R. Ferket, *NC State University, Raleigh, NC USA.*

The objectives of this experiment were to investigate the effects of a growth-promoting oligosaccharide and two traditional antibiotics on the physical and microbial attributes of the gastrointestinal tract of male turkeys. Day old Hybrid Large White male poult were assigned to four dietary treatments: Control, Bio-Mos[®] (MOS), Bambarmycins (BM), and Virginiamycin (VM). There were eight replicate floor pens per treatment with 20 birds per pen reared from 1 to 140 days of age. All data were analyzed using the GLM procedure of SAS (1994). At 12 wks of age, three birds per pen were randomly sampled to measure the following: intestinal section weights, length, density, and mucosal and muscularis weights. Jejunal and cecal digesta samples were taken for

was formulated with corn, soybean meal and extruded soybean to contain on as-fed basis (DM86.9%) ME 12.55 MJ/kg, CP 20%. Ground rice hull was used to dilute the basal diet to formulate diets with 5.0%, 8.0% and 11.5% lower in ME, CP and amino acid contents than basal diet. The doses of CFE in diets ranged from 0% up to 0.23%. 360 1-d-old Avian male broilers were randomly allotted into the 6 treatments with 4 replicates of 15 birds each, and were fed ad libitum until 42 days old. Then 8 birds per treatment were selected for a 4-d metabolism trial, during which excreta were completely collected for measuring nutrient utilizations. Bodyweight gain and feed efficiency were improved quadratically ($P < 0.01$) as DNC increased, and so did the utilizations of dietary energy, protein and dry matter. Performance and nutrient utilizations responded quadratically ($P < 0.01$) to the doses of CFE, and reached peak when CFE dose was 0.1%. ME-equivalent value (MEV) of CFE was calculated by the difference of measured ME of diets with vs. without CFE supplementation at the same DNC. When CFE was included in diets at 0.1%, its MEV was 173, 343, 451 and 586 MJ/kg respectively for the diets of control, and 5%, 8% and 11.5% lower in DNC compared to control. It is concluded that MEV of feed enzymes varies with dietary nutrient concentrations.

Key Words: ME-Equivalent Value, Feed Enzymes, Broilers

ammonia, pH, lactate, volatile fatty acids, and dietary AME_N measurement. Birds fed MOS exhibited no effects on physical parameters while BM resulted in significantly increased duodenal attributes compared to control ($P \leq 0.05$). In contrast, feeding VM resulted in significantly decreased duodenal, ileal, cecal, colon weights and decreased duodenal, jejunal, and ileal muscularis weights compared to control ($P \leq 0.05$). In comparison to controls, jejunal propionate and total VFA production was decreased in the MOS and BM treatments, respectively. Feeding VM resulted in a significantly increased jejunal pH level and significantly decreased propionate production as compared to control-fed birds ($P \leq 0.05$). Dietary AME_N was not significantly affected by treatment. Results suggest that MOS affects the enteric ecosystem by a different mode than antibiotic (BM and VM) growth promotants.

Key Words: Turkey, Mannanoligosaccharide, Antibiotics

701 Effects of ratios of dietary linoleic to linolenic acid on hen performance, mitogenic response, and antibody production of White Leghorn hens against Newcastle disease vaccine. U. Puthongsiriporn*¹ and S. Scheideler¹, ¹*University of Nebraska-Lincoln.*

The objective of this study was to investigate the effects of ratio of dietary linoleic to linolenic acid on hen performance, mitogenic response, and antibody production against Newcastle disease (NDV) vaccination in the second phase of the laying cycle. A corn-soybean meal diet was supplemented with flaxseed to have ratios of dietary linoleic to linolenic acid (n:6/n:3) of 17:1 (control), 8:1, or 4:1. Each diet was randomly assigned to 6 replicate pens with 5 hens/pen. Hy-Line W-36 hens were fed the diets from 53 to 58 wks of age. At the age of 57 wks, hens were boosted with NDV vaccine (Merial Select[®]; 25-5,000 Pkg/dose). No differences on feed consumption, body weight, egg production, and egg quality were observed throughout the study. The n:6/n:3 ratio did affect mitogenic response and antibody production of hens only after vaccination. Mitogenic response to concanavalin A (Con A) was significantly greater ($P \leq 0.02$) in hens fed n:6/n:3 of 8:1 (0.742), or 4:1 (0.728) as compared to the control (0.577). Mitogenic response to Salmonella typhimurium lipopolysaccharide (LPS) was greater ($P \leq 0.008$) in hens fed n:6/n:3 of 8:1 (1.028), or 4:1 (0.991) as compared to the control (0.899). Dietary decrease in n:6/n:3 induced higher ($P \leq 0.0004$) antibody production against NDV vaccine measured by an ELISA test. Mortality rate of hens in each treatment was 0% during the study. These results indicate that a decrease in the ratios of dietary linoleic to linolenic acid (n:6/n:3) enhanced mitogenic response and antibody production against the Newcastle disease vaccine, but not performance of White leghorn hens in the second phase of the laying cycle.

Key Words: Ratios of Linoleic to Linolenic Acid, Mitogenic Response, Newcastle Disease Vaccine

702 Effect of dietary xanthophylls on carotenoid content of lymphoid tissues of layer chicks. E.A. Koutsos*, C.C. Calvert, and K.C. Klasing, *University of California, Davis; Davis, CA.*

Layer chicks were fed diets ranging from 0 to 48 mg/kg total xanthophyll (xan) to determine the effect of dietary xan on tissue xan concentration. Dietary xan consisted of lutein (lut) and zeaxanthin (zea) (Oroglo Dry) and canthaxanthin (cantha) (Carophyll Red) at a ratio of 1.5:1. After 4 weeks, splenic macrophages, plasma, red blood cells (RBCs), liver, thymus and bursa were analyzed for xan content by HPLC. Neither bursa lut nor zea correlated with dietary xan ($p=0.79$, $p=0.10$, respectively); cantha was undetectable. Thymus lut and cantha correlated with diet levels: thymus lut (ug/g) = $0.06+(0.02*\text{diet lut (ppm)})$ ($r^2=0.93$, $p<0.001$); cantha = $-0.01+(0.06*\text{diet cantha})$ ($r^2=0.83$, $p<0.001$). Thymus zea tended to be correlated with diet zea ($p=0.08$). Plasma xan correlated with diet: plasma lut (ug/ml) = $0.03+(0.05*\text{diet lut})$, ($r^2=0.83$, $p<0.001$); zea = $-0.02+(0.014*\text{diet zea})$, ($r^2=0.69$, $p<0.002$); cantha = $0.02+(0.09*\text{diet cantha})$, ($r^2=0.88$, $p<0.001$). RBC lut and zea were not correlated with diet xan ($p=0.16$, $p=0.26$); cantha was undetectable. Liver lut correlated with diet: lut (ug/g) = $0.24+(0.026*\text{diet lut})$, $r^2=0.78$, $p<0.001$, but liver zea and cantha were not correlated with dietary xan ($p=0.44$, $p=0.56$). Total liver xan related to diet xan by a polynomial relationship: liver xan(ug/g) = $1.56+(0.13*\text{diet xan})-(0.002*\text{diet xan}^2)$ ($r^2=0.77$, $p<0.003$), suggesting that liver xan plateaued at approximately 20 mg xan/kg diet. Splenic macrophages contained very high levels of lut (avg=34.8 ug/g 9.7) and zea (56.7 ug/g 10.4), and there was no correlation with diet lut or zea ($p=0.40$, $p=0.42$). Macrophage cantha was not detected. This suggests that macrophages, unlike other tissues, may sequester xan from egg yolk, and maintain xan levels regardless of diet. Liver, bursa and RBC xan appear to plateau within the tested dietary range. In contrast, plasma and thymus xan appeared to continue to increase in a linear response to diet xan.

Key Words: Xanthophyll, Macrophage, Layer

703 Fluid therapy of poult infected with turkey corona virus (TCV) and *E. coli*. L. El-Hadri*, M. A. Qureshi, J. D. Garlich, P. R. Ferket, and J. S. Guy, *NC State University, Raleigh, NC USA.*

Supplementation of drinking water with electrolytes, glucose, betaine may help sustain poult afflicted with enteric disease. This hypothesis was tested in 2 experiments with poults receiving an oral inoculation containing TCV and *E. coli* at 7 d of age. In trial 1, beginning at 2 d post inoculation (DPI) poults were randomly assigned to one of the 4 treatments: unsupplemented control (C), electrolytes (E), electrolytes + 25 g glucose/l (EHG), electrolytes + 13 g glucose/l (ELG). Mortality was recorded daily and weights of whole body, bursa, and thymus were taken at 7 and 14 DPI. Birds treated with E (99 mOsm), EHG (252 mOsm) and ELG (189 mOsm) gained more weight than controls (0 mOsm) ($P<0.01$). Feed conversion was reduced ($P<0.002$) in all the supplemented water treatments. In comparison to the E and C treatments, EHG and ELG resulted in lower mortality rates (63 and 52% vs 37 and 36%, $P<0.01$), and greater thymus weight (0.106 g and 0.11 g vs 0.195 g and 0.186 g, $P<0.006$) at 7 DPI. Trial 2 tested betaine (B) as an osmotic modulator in therapeutic fluids containing high (HG) and low (LG) glucose concentration, using a 2X3 factorial arrangement of 2 levels of betaine (0 and 300 mg/l) and 3 levels of glucose (0, 13, and 25 g/l). A B X G interaction effect indicated B depressed body weight gain in LG groups (BLG, 231g vs LG, 267 g, $P<0.05$), whereas it had no effect on HG birds (BHG, 187 g vs HG, 162 g, $P>0.05$). Bursa and thymus weights were increased by the G treatments only ($P<0.003$). Fluid consumption at 3 and 4 DPI was increased by G but not B. Although all fluid treatments had some benefit relative to the controls, the greatest reduction in mortality rate was observed when G and B were included in the fluid together (6.5% vs 20%, $P<0.05$). Supplementation of drinking water with electrolytes (99 mOsm) plus glucose (low, 189 mOsm, or high, 251 mOsm) improved survival and immune organ weights of TCV and *E. coli* -infected poults.

Key Words: Electrolytes, Glucose, Betaine

704 Effect of dietary betaine on intestinal leukocyte numbers, osmolality, and morphology during an *Eimeria acervulina* challenge. K. C. Klasing*¹, K. L. Adler¹, C. C. Calvert¹, and J. C. Remus², ¹*University of California, Davis, CA*, ²*Finnfeeds, St. Louis, MO.*

In addition to its methyl-donor activities, betaine is used by cells to defend against hyperosmolality. We examined relationships between betaine, osmolality (OS), and coccidiosis. Broiler chicks were fed corn-soy diets containing either 0.0, 0.05, or 0.10% betaine (8 pens/diet; 7 chicks/pen) and half were challenged at 14 d with 4.6×10^4 oocysts (Cocci). Cocci decreased weight gain and feed efficiency, while betaine did not affect either. Intestinal samples from 1 chick/pen were taken on 4 and 7 later. Cocci increased OS of the duodenal and jejunal mucosa. Betaine decreased OS of the duodenum ($P<0.01$), especially in Cocci challenged birds (interaction $P<0.07$). Cocci increased the thickness ($P=0.04$) and number of leukocytes ($P<0.01$) in the duodenal lamina propria. The increase in leukocyte numbers was greatest at high betaine levels (interaction $P=0.05$). The height of duodenal villi was decreased by Cocci ($P=0.05$) and this effect was ameliorated by 0.10% betaine (interaction $P=0.04$). Intra-epithelia leukocyte numbers were increased by Cocci ($P<0.01$) and this increase was greatest with 0.05 and 0.10% betaine (interaction $P=0.04$). Villi width and crypt depth were unaffected by the treatments. In a second experiment, peritoneal macrophages (Macs) or peripheral blood heterophils (Hets) were incubated in media with an osmolality of either 200, 310, 600, or 900 milli-osmol and either 0.0, 0.1, 0.5 or 1.5 mM betaine (4x4 factorial). *Eimeria* were added to cultures after 6 hrs exposure to media. Phagocytosis by Macs was decreased by hypo-OS (200) and hyper-OS (600, 900) media relative to iso-OS media ($P=0.015$). Phagocytosis by Hets was decreased only by 900 milli-osmol. In Macs, but not Hets, phagocytosis was increased by 0.1 mM betaine compared to 0.0 betaine ($P=0.05$). Macs and Hets incubated in hyper-OS media had decreased chemotaxis and NO release. Betaine increased NO release by Hets ($P=0.039$).

Key Words: Coccidiosis, Betaine, Villi

705 Utilization of metabolizable energy in broilers. J. van Milgen*¹, J. Noblet¹, S. Dubois¹, B. Carr², and H. Juin³, ¹*INRA, St-Gilles, France*, ²*INRA, Nouzilly, France*, ³*INRA, Le Magneraud, France.*

Four groups of broilers (ISA 915) were used to study the effect of body weight on the partitioning of metabolizable energy between protein and lipid deposition, and components of heat production. Broilers were group-housed in a cage measuring 105 x 65 x 45 cm equipped with two feeders of 30 cm each. The cage was mounted on force sensors to measure physical activity of the animals. Temperature was maintained at 21C (60-65% relative humidity) and a 22 h/d lighting schedule was adopted. Animals had ad libitum access to feed (20.5% CP, and 12.7 MJ ME/kg feed) and water. Heat production was measured using indirect open-circuit calorimetry whereas protein and lipid deposition was determined through nitrogen and energy balances. Heat production was measured during two successive weeks. Each week consisted of one day of adaptation, five days of collection of excreta and measuring feed intake and heat production when fed, and one day of measuring the fasting heat production (temperature 24C). In the first week, heat production and nitrogen balance were measured in groups of 11-12 broilers (starting at 21 d of age). At the start of the second week, group size was reduced to 8-9 broilers. The average weight of the broilers was 1.00 and 1.61 kg during the first and second week, respectively. Dry matter feed intake per broiler increased from 120 g/d in week 1 to 161 g/d in week 2. Growth rates (prior to fasting) averaged 89 and 100 g/d for weeks 1 and 2, respectively. To express maintenance energy requirements relative to BW (prior to fasting), the model $Y = aBW^b$ was used. For the fasting heat production, the value of "b" significantly differed from 0.75 but not from 0.60, resulting in an activity-free fasting heat production of 490 kJ/(kg BW^{0.60})/d. Similarly, ME intake and total heat production were not affected by stage of growth when expressed per (kg BW)^{0.60}. On average over the two weeks, broilers consumed 1764 kJ ME/(kg BW)^{0.60}/d, 53.4% of which was lost as heat. The retained energy was partitioned between protein (47.4%) and lipid (52.6%). Heat production was partitioned between fasting heat production (52.1%), physical activity (17.0%) and thermic effect of feeding (30.9%). For the latter two components, this represented 9.1 and 16.5% of ME intake, respectively.

Key Words: Broilers, Energy Metabolism, Heat Production

706 Broiler bone metabolism changes significantly during acute stress. Alfonso Jr Mireles*, Sun Kim, Russell Thompson, and William R. Amundsen, *Foster Farms, Modesto, CA.*

A preliminary study showed acute stress caused by an *E. coli* lipopolysaccharide (LPS) subcutaneous injection significantly decreased weight, breast yield, and bone tibia bone strength. Because weight gain and tibia strength are known to be directly correlated, this study was conducted to determine whether this observed loss of bone quality is also affected by an acute inflammatory response. There were 5 treatment groups of 17 cockerels each. Birds were subcutaneously injected *E. coli* LPS at 0, 33, 66, 100, or 425 micrograms/100 grams body weight. Weight gains after 3 days were 263, 209, 195, 186, and 127 grams/bird respectively. Similarly, tibia strength scores were 43.1, 38.8, 38.5, 34.0, and 32.2 Kgs. Tibia elasticity scores were 3.91, 3.66, 3.51, 3.43, and 3.35 mm. Three day mortality was 5, 0, 10, 15, and 40% respectively. Linear regression equations were calculated for each treatment group, and actual weight vs. predicted bone strength were plotted by treatment group. Results showed that, at the same weight, tibia strength is directly related to LPS dosage. As the level of stress (LPS) increased, the regression lines shifted downwards and away from the non-stressed group line. Results suggested bone catabolism is an essential part of an acute stress, which can be used as a sensitive index for nutritional immunomodulation.

Key Words: Nutritional immunomodulation, Bone strength and metabolism, Acute stress

707 Growth promoters in broiler feed (coccidiostat + antibiotics) may play a crucial role during acute stress. Alfonso Jr Mireles* and Sun Kim, *Foster Farms, Modesto, CA.*

To evaluate the effect of growth promoters in broiler feeds during acute stress conditions, 2 treatments were prepared (Control with 50 gms Salinomycin + 25 gms Bacitracin MD/ton (C) vs. No Feed Additives (NFA)). A field experiment was conducted during summer and lasted 45 days. There were 10 replicate pens of 50 birds per treatment. Twenty males per treatment were sampled at 35 days for tibia and breast quality. At 39 days, 14 birds per treatment were injected 100 micrograms *E. coli* lipopolysaccharide (LPS) subcutaneously per 100 grams body weight and their performance was compared vs. 14 non-injected birds. At 35 days, NFA birds had weaker ($P < 0.05$) tibias (37.3 vs 32.7 Kgs), lower tibia yields (1.1 vs 1.0%) and similar breast yields as C birds. At 45 days, NFA birds had poorer ($P < 0.05$) weight gain (2.4 vs 2.3 Kg), feed/gain (1.72 vs 1.77), and similar mortality as C birds. A LPS challenge decreased ($P < 0.05$) weight (2.23 vs 2.09 Kg), tibia strength (35.8 vs 32.3 Kg), breast yield (14.9 vs 14.3%), and increased mortality (0 vs 12%). C birds, however, handled the stress significantly better ($P < 0.05$) than NFA birds. At 210 minutes post-LPS, body temperature of C birds was lower than that of NFA birds (42.6 vs 43.0 °C). Coccidiostats and/or antibiotics appear to impart a critical protective effect on broilers during acute stress. This stress is detrimental to breast yield and bone strength and quality.

Key Words: Acute phase (inflammatory) response and stress, Growth promoters, Nutritional immunomodulation

708 Impact of galactose on growth performance, toxicity and metabolizable energy when fed to broiler chicks. M.W. Douglas* and C.M. Parsons, *University of Illinois, Urbana, IL USA.*

A study was conducted to determine the effect of increasing dietary galactose (GAL) on growth performance, toxicity and metabolizable energy when fed to commercial broiler chicks. One-day old Ross x Hi Y male chicks were randomly assigned to one of six treatments. The treatments were a 22% CP corn-soybean meal-dextrose basal diet with the addition of 0, 2, 4, 6, 10 or 15% GAL at the expense of dextrose. The diets were fed from 0 to 21 days of age. Metabolizable energy of the diets was determined from collection of excreta for Days 18 to 21. The 15% GAL treatment resulted in high mortality (26%) by Day 3 and was terminated. The 10% GAL treatment also resulted in increased mortality, most of which occurred during the 7 to 14 d period. However, the 10% GAL diet had no significant negative effect on growth performance compared to the basal diet (0% GAL). There was no difference in mortality for the 0, 2, 4 and 6% GAL treatments. Addition of GAL at the 2, 4, and 6% level resulted in numerically increased weight gain and feed

efficiency over chicks fed 0% GAL, with the increases being 10% and significant ($P < 0.05$) for the 4% inclusion rate. Feed intake for the 21 d period was not significantly ($P > 0.05$) different for any level of GAL fed (0-10%). Metabolizable energy was greatest for chicks fed 0% GAL (3.149 kcal/g DM). Supplementation of 2, 4, 6 and 10% GAL resulted in decreases in ME_N of 4, 6, 7 and 11%, respectively (significant linear response, $r^2 = 0.85$). Our results indicate that low levels of GAL may increase growth performance of commercial broiler chicks even though dietary ME_N may be reduced.

Key Words: Chicks, Galactose, Growth Performance

709 The effect of fasting at different ages on growth and tissue dynamics in the small intestine of the young chick. David Sklan*, Assaf Geyra, and Zehava Uni, *Faculty of Agriculture, Hebrew University of Jerusalem, Israel.*

The small intestines of hatching chicks undergo rapid developmental changes in the immediate posthatch period when the birds are making the transition from endogenous nutrient supply from yolk to dependence on exogenous feed. This transition usually only begins 48 h or more after hatch due to logistical considerations. The effects of fasting for 48 h at different times during this critical period on small intestinal development and enterocyte dynamics were examined by morphometric determinations and use of staining for proliferative cell nuclear antigen and 5-bromo-2-deoxyuridine. The effects of fasting were specific to both time of fasting and to the intestinal segment examined. Decreased development was found in the duodenum and jejunum and less apparent in the ileum. Fasting between 0 and 48 h decreased crypt size in the duodenum and jejunum, the number of crypts per villus, crypt proliferation, villus area and the rate of enterocyte migration. Fasting at later times resulted in smaller effects, although the jejunum appeared to be the most sensitive of the intestinal segments. Growth was correlated with the number of cells in the crypts, the number of cells along the villus and the segment surface area.

Key Words: Small intestine, Fasting, Chicks

710 Influence of source of energy of the pre-starter diet on performance and nutrient digestibility of broiler. M. J. Aranibar, M. I. Gracia, R. Lazaro*, and G. G. Mateos, *Universidad Politecnica de Madrid, Spain.*

A trial was conducted to investigate the influence of different energy sources in the pre-starter diet on performance and nutrient digestibility of broiler chicks. There were five treatments and five replicates of four chicks per treatment. The experimental diets (0 to 10d) were based on corn and soybean meal and included either 6.8% of a fat source (sunflower oil, fish oil or lard) or 15.0% of a carbohydrate source (starch or sucrose). The nutrient content of these diets was approximately 3,150 kcal AMEn/kg and 1.33% Lys for the fat diets and 2,920 kcal AMEn/kg and 1.23% Lys for the carbohydrate diets. From 10 to 21d all the birds received a common diet containing 3,000 kcal AMEn/kg and 1.33% Lys. Productive performance was measured at 10 and 21d and apparent fecal digestibility of crude protein (CPD) and crude fat (CFD), and the AMEn of the diets were determined at 4, 7, and 10d of age. No differences in performance were observed among treatments at 21d of age. As expected, birds fed the fat diets had similar body weight but better feed conversion ($P < 0.01$) than broilers fed the carbohydrate diets at 10d of age. Apparent CPD and AMEn of the diets increased with age (48.3, 55.4, and 58.4%; $P < 0.001$, and 2,637, 2,731, and 2,853 kcal AME/kg; $P < 0.001$ at 4, 7, and 10d of age, respectively). Unexpectedly, apparent CFD decreased at 7d as compared to 4d (67.7 vs 76.4%; $P < 0.01$) and then increased slightly at 10d of age (70.5%). The differences on CFD between 4 and 7d were more pronounced for fish oil (80.8 vs 58.4%; $P < 0.001$) and lard (77.8 vs 62.3%; $P < 0.001$) than for sunflower oil (84.7 vs 80.3%; $P > 0.05$). We conclude that fat digestibility of chicks was lower at 7 than at 4 or 10d and that type and source of energy used from 0 to 10d does not influence broiler performance at 21d.

Key Words: Broilers, Digestibility, Fat

711 Starch digestion rate in the small intestine of broilers differs among feedstuffs. R.E. Weurding^{*1}, A. Veldman¹, W.A.G. Veen¹, M.W.A. Verstegen², and P.J. Van der Aar¹, ¹*Institute for Animal Nutrition 'De Schothorst', Lelystad, The Netherlands*, ²*Wageningen University and Research Center, Wageningen, The Netherlands*.

A digestibility trial with 720 broilers was performed in which starch digestion of twelve diets, varying in starch source, was determined in three different segments of the small intestine as well as total starch digestion. The choice for the starch supplying feedstuffs was made considering known differences in starch accessibility, -structure and -composition. Based on digestibility coefficients and retention times in the different gut segments, in vivo starch digestion rate was calculated. Ileal starch digestion varied from 33% (potato starch) to 99% (tapioca). No starch degradation was observed in the hind gut. Dietary mean retention time in the small intestine varied from 136 min (barley diet) to 182 min (potato diet). Starch digestion rates varied from 0.5 /h (common beans) to 4.3 /h (tapioca). Ranking of feedstuffs according to total starch digestion (in increasing order) was: potato starch, legume seeds, cereal grains, tapioca. An in vitro technique which mimics passage through the gastrointestinal tract (GIT) of humans was adapted to mimic passage through the GIT of broilers. In vitro starch digestion was measured at different incubation times in the same diets as used in the in vivo digestion trial. From the starch digestion coefficients at the different incubation times, starch digestion rate was estimated. Correlations between in vivo and in vitro starch digestion data were calculated. In vitro starch digestion after 2 h incubation correlated well with starch digestion in the posterior jejunum ($r = 0.94$) and in vitro starch digestion after 4 h incubation correlated well with starch digestion in the posterior ileum ($r = 0.96$). In vitro starch digestion rate was lower, but showed a good correlation with in vivo starch digestion rate ($r = 0.87$). It was concluded that starch digestion rate in broilers varies among feedstuffs and can be predicted by the adapted in vitro method.

713 Use of the OptiBreed Sperm Quality Analyzer[®] for evaluating semen quality of turkey breeders. S. L. Neuman^{*1}, C. D. McDaniel², J. Radu³, L. Frank³, and P. Y. Hester¹, ¹*Purdue University*, ²*Mississippi State University*, ³*Alpharma, Inc.*

The OptiBreed Sperm Quality Analyzer[®] (SQA) measures overall sperm quality as a Sperm Quality Index (SQI). The SQI value generated by the SQA is indicative of turkey sperm concentration, motility, and viability (Neuman et al., *Poultry Sci.* 79:suppl.1:49) The objective of the current study was to monitor the quality of semen in a turkey breeder flock throughout its semen production cycle. A commercial secondary breeder flock of BUTA breeder toms was monitored for sperm quality at 4-wk intervals beginning at 32 wk of age. Individual ejaculates were collected from the same 200 male breeders each month for 7 months. The semen was diluted 50-fold in 0.85% saline prior to determining the SQI for each individual bird. The SQI values were measured within 5 to 10 minutes of collecting the ejaculates. Individual semen volume was also determined gravimetrically. A univariate procedure, conducted monthly on individual SQI values and semen volume, indicated that SQI values were not normally distributed with the exception of month 7 in which SQI values were normally distributed (Shapiro-Wilk $W = 0.9939$, $P = 0.65$ for month 7). Semen volume was normally distributed during months 1, 2, 6, and 7 ($P > 0.05$). The CV for SQI was highest during month 1 at 26%, but decreased during subsequent months and averaged 15%. The CV for monthly semen volume averaged 32%. An ANOVA, conducted on semen traits to evaluate time effects, indicated that mean SQI values were lowest during months 1 and 7 of semen production with peak values occurring during months 2 through 6. Semen volume was at its lowest during the first month of production with subsequent increases during months 2 through 7. Correlation for all months between semen volume and SQI values was low ($r = 0.17$, $P < 0.0001$). In conclusion, the SQA can be used as a tool to monitor semen quality of breeder toms as a flock ages.

Key Words: Sperm Quality Analyzer, Sperm Quality Index, Turkey breeder

The practical relevance of starch digestion rate will be studied in growth trials.

Key Words: Starch, Broilers, Digestion rate

712 Effect of colistin and aureomycin on intestinal microorganism and their relationship with the riboflavin metabolism of broilers. H. Y. Cai^{*1}, L. Wang¹, and G. H. Liu¹, ¹*Feed Research Institute, Chinese Academy of Agricultural Sciences, Beijing, P. R. China*.

To investigate the interrelationship between antibiotics, intestinal microorganisms and riboflavin metabolism in broilers, a total of 280 one day of age AA broilers were randomly allotted to 5 dietary treatments. Experimental diets were formulated to contain of two antibiotics at two different dosages (aureomycin: 50, 100 mg/kg; colistin: 10, 20 mg/kg) and the control without adding antibiotics. At 3 wk of age, four birds were taken at random from each of the treatment groups for the riboflavin (B2) analysis of cecal contents and determination of differential microbial counts. All data was statistically analyzed by Statistica 6.0 software and multiple comparisons conducted by DUNCAN. There was a gradual but significant ($P < 0.05$) reduction in *E. coli* numbers with increasing levels of either colistin or aureomycin. Colistin supplementation at 20 mg/kg significantly ($P < 0.05$) increased bifidobacterium numbers. Similarly, aureomycin supplementation at 50 mg/kg and 10 mg colistin/kg numerically increased bifidobacterium counts ($P > 0.05$). The B2 concentrations in the broilers' cecal contents at 21 days of age were significantly higher ($P < 0.05$) in birds receiving 20 mgcolistin/kg. Aureomycin supplementation at 100 mg/kg numerically increased the cecal level of B2 ($P > 0.05$). The B2 concentrations in the colons of 21 day-old birds fed either 100 mg aureomycin/kg or 20 mg colistin/kg were numerically reduced ($P > 0.05$) indicating a possible improvement of B2 absorption in the hindgut.

Key Words: Broilers, Antibiotics, Riboflavin

PSA Physiology: Reproduction

714 Effects of Feeding Regimen and Strain on Fertility of Broiler Breeder Hens as Indicated by the Perivitelline Layer Sperm Penetration Assay. R. A. Renema^{*}, F. E. Robinson, and G. M. Fasenko, *University of Alberta, Edmonton, AB., Canada*.

The fertility of broiler breeder hens can be reduced by overfeeding. Monitoring fertility is a key step in the early diagnosis of reproductive problems. The Perivitelline Layer (PL) Sperm Penetration Assay has been demonstrated to be an alternative, non-incubation method of fertility assessment. In this study, the PL Sperm Penetration Assay was used to assess fertility in broiler breeder hens of four strains either feed restricted (FR) or ad libitum (AL) fed from photostimulation. Four strains of pullets (Shaver Starbro, Cobb 500, Hubbard Hi-Y, Avian 24k) were reared on a common growth curve. Strains were assigned the anonymous labels W, X, Y, or Z. Forty pullets of mean BW from each strain were individually caged at 20 wk of age. Birds were photostimulated at 22 wk and either maintained under RF conditions, or switched to an AL regimen. At 45 wk of age, 15 hens/tmt were artificially inseminated with pooled semen, and eggs collected 2-9 d after insemination. Eggs were assessed for PL sperm hole number at 40X and 100X magnification and data summarized in 3, 3-d periods (2-4 d, 5-7 d, and 8-10 d). There were no strain differences in the number of PV sperm holes determined at 100X magnification. However, at 40X magnification, 146 PV holes were present in Strain W eggs 2-4 d after insemination compared to 72 and 80 in Strain X and Y eggs, respectively. Although PV hole numbers were low in Strain Y eggs during the 2-4 d period, they did not subsequently decline as rapidly as in other strains. There were 43.1% and 34.8% fewer PV sperm holes in AL eggs than in RF eggs during the 2-4 d post-insemination period when examined under 100X and 40X magnification, respectively. Despite differences in PV sperm holes due to feeding level, actual fertility was affected by AL feeding in a strain-dependent manner. However, as breeder strain influenced the PV hole number independently of actual fertility, the value of the PV hole method for strain comparison was reduced.

Key Words: Broiler breeder, Fertility, Genetic strain

715 Differences in in vitro sperm hydrolysis of the perivitelline layer between two commercial lines of turkeys. B. D. Fairchild* and V. L. Christensen, *North Carolina State University, Raleigh, NC USA.*

Sperm penetration of the ovum inner perivitelline layer (IPVL) is positively correlated with fertility. Higher sperm penetration of the IPVL is indicative of successful insemination and can be positively associated with filling of the sperm storage tubules in the uterovaginal region of the oviduct. The hypothesis tested was that in vitro sperm hydrolysis of the IPVL would differ between two commercial turkey lines at two different periods in production. The objectives were to determine strain, age, male and female influence on sperm hydrolysis of the IPVL. Two experiments were conducted. In Experiment 1 strain and hen age were examined. Two commercial strains (N & H) and two hen ages within the laying period (early period=1-4 weeks of lay and mid period=12-16 weeks of lay) were used as factors in a factorial design. In Experiment 2, Tom (HM and NM) and Hen (HF and NF) were arranged in a factorial design to examine male and female influence on sperm hydrolysis. Eggs were obtained at oviposition from non-fertilized hens. Perivitelline layer (PVL) was isolated from non-germinal disc regions of the egg, sectioned into 1cm² pieces, then incubated with 25x10⁶ viable sperm cells. After incubation, all PVL sections were rinsed, fixed on a microscope slide and stained. Holes from sperm hydrolysis were then counted. In Experiment 1, young hens had significantly more hydrolyzed holes than older hens and H hens had more hydrolyzed holes than N hens. No interaction between age and commercial line was detected indicating that both lines performed similarly at both production periods examined. In Experiment 2, HM and HF had significantly more sperm hydrolyzed holes than NM and NF. The results of these two experiments suggest that strain, hen age, sire and hen have significant effects on sperm hydrolysis of the IPVL and that by crossing sires and hens of different lines no gain in sperm hydrolyzed holes was achieved in vitro.

Key Words: Turkey, Fertility, Sperm hydrolysis

716 Production of germline chimera by transferring gonadal germ cells (GGCs) collected from 7 or 9 day-old chick embryos. A. Tajima*¹, M. Ohara², T. Minematsu¹, T. Kuwana³, and Y. Kanai¹, ¹*Institute of Agriculture and Forestry, University of Tsukuba*, ²*Poultry Division, Takikawa Agricultural Experiment Station*, ³*Pathology Section, National Institute for Minamata Disease.*

Fertilized eggs of the genetically selected White Leghorn line (SH strain) produced at Takikawa Animal Experiment Station (Hokkaido, Japan) were transported to University of Tsukuba (Ibaraki, Japan) by a commercial courier. Eggs were incubated at 37.8 C for 7 or 9 days and the recovered gonads were dissociated mechanically. Dissociated gonadal cells containing 7-day-old or 9-day-old gonadal germ cells (7d-GGCs or 9d-GGCs, respectively) were suspended in freezing medium containing 10 % dimethyl sulphoxide (DMSO). The cell suspension was frozen at 1 C/min. until the temperature reached -80C; this was followed by immersing the cells into liquid nitrogen at -196 C then stored up to 3 months. Between twenty five to one hundred frozen/thawed GGCs were injected into the dorsal aorta of stage 14-15 (H&H) Rhode Island Red (RIR) embryo from which blood was drawn prior to germ cell injection. The injected embryos were incubated until hatched and hatched chicks were raised until sexually mature. Hatchability as well as male:female ratio were 78% (7/9) and 5:2, and 42% (5/12) and 3:2 for embryos transferred with 7d-GGCs and 9d-GGCs, respectively. Upon reaching sexual maturity, a progeny-test was performed for 4-19 weeks by mating recipient chicks with normal RIR of the opposite sex. Out of 5 male 7d-GGC recipient, one male produced chick derived from transferred GGCs and the ratio was 1.7 % (1/58). Out of 3 male 9d-GGC recipient chick, one male produced chick derived from transferred GGCs and the ratio was 3.9 % (8/197). None of the female recipients hens produced chick derived from transferred GGCs. Present results demonstrate that frozen/thawed male 7d-GGCs and male 9d-GGC are still capable of producing germ-line chimeras in chicken when injected into blood stream of 2-day-old recipient embryo.

Key Words: Germ line Chimeras, Gonadal Germ Cells, Conservation of Avian Genetic Resources

717 Luteinizing Hormone, Progesterone, and Estradiol-17 β Concentrations, and distribution of Hierarchical Follicles in Normal and Arrested-laying Turkey Hens. H.-K. Liu, D.W. Long, and W.L. Bacon*, ¹*The Ohio State University, Wooster OH.*

Photosensitive turkey hens of a line selected for increased egg production (Egg line) were photostimulated with constant light (24 h light: 0 h dark⁻¹) at 30 wk of age. Egg laying became arrested in 6 of the 12 hens after only 2 to 3 wk of laying. Comparisons of ovarian and oviductal morphology and changes in plasma hormones [luteinizing hormone (LH), progesterone (P₄) and estradiol-17 β (E₂)] over 10 d of hourly serial bleeding between the laying and arrested-laying hens were made. The number of hierarchical follicles (follicles > 1.0 g) was much greater in the arrested-laying hens than in laying hens. Some of the arrested-laying hens presented a poly-cystic ovarian follicle condition, with a large number of follicles slightly heavier or much heavier in weight than F₁ follicles of the laying hens. The oviducts of the arrested-laying hens were fully developed and similar in weight to those of laying hens. The plasma concentration of LH in the arrested-laying hens was relatively low and without preovulatory surges, which were detected in the laying hens. The baseline concentration of LH in the laying hens and the interval between preovulatory surges were similar to previously reported values for laying hens of the Egg line. The concentration of P₄ in most of the arrested-laying hens was maintained at a relatively high level without preovulatory surges. The baseline and surge amplitude concentrations of P₄ in the laying hens and interval between surges were similar to previously reported values for laying hens of the Egg line. The concentrations of E₂ were not different between normal and arrested laying hens. In conclusion, the relatively high and surge-less concentration of P₄ in the plasma of the arrested-laying hens might block ovulations but not block entrance of follicles into the hierarchy nor alter their hierarchical growth, leading to an accumulation of numerous F₁ or larger sized follicles in the ovary. Further, some of the accumulated mature follicles may resume an abnormal growth leading to the formation of cystic ovarian follicles.

Key Words: Turkey hen, arrested-laying, progesterone

718 Profile of Plasma Hydroxyproline in Laying Hens During an Ovulatory Cycle. J. I. Orban*¹ and P. Y. Hester², ¹*Southern University at Shreveport, LA*, ²*Purdue University, IN.*

Hydroxyproline is required for collagen formation and is associated with bone remodeling. In humans, estimation of hydroxyproline level in the blood and urine has become a useful method to assess bone turnover, especially in bone degradation. In laying hens, bone integrity depends on calcium need, which is in part associated with the rate and magnitude of bone remodeling. The objective of this study was to determine the level of free plasma hydroxyproline in laying hens in relation to plasma calcium level during the ovulatory cycle to assess when bone resorption occurs to provide additional calcium for eggshell calcification. Twenty-five laying Leghorn hens (12 hens, 25 wk-old and 13 hens, 60 wk-old) were bled at 0, 5, 10, 15 and 20 h post-oviposition. Blood plasma obtained was analyzed for free hydroxyproline level using a modified method of Dabev and Struck (1971, *Biochem. Med.* 5:17). Calcium was analyzed using a Sigma calcium kit (St. Louis, MO 63178). Data were analyzed using a one-way ANOVA with a split plot in time (h post-oviposition). Both the 25 and 60 wk-old hens showed a significant (P < 0.0001) increase in plasma levels of hydroxyproline at 15 h post-oviposition (8.8 ug/mL for 25 wk hens and 8.0 ug/mL for 60 wk hens) as compared to basal levels at 0, 5, 10, and 20 h post-oviposition (6.2, 6.4, 6.4, and 7.2 ug/mL for 25 wk hens and 6.3, 7.1, 6.6, and 5.7 ug/mL for 60 wk hens, respectively, pooled SEM = 0.4). Mean plasma calcium levels during the time period for both age groups were 36 (0 h), 39 (5 h) 34 (10h) 23 (15h) and 18 mg % (20 h), pooled SEM = 2. The significant (P < 0.001) drop in calcium level from 15 to 20 h during the ovulatory cycle indicated the period of active eggshell calcification during which the spike increase in hydroxyproline was observed. Results indicate that the 15 h post-oviposition spike increase in plasma hydroxyproline level could represent bone turnover or medullary bone resorption to release additional calcium for eggshell calcification.

Key Words: Plasma hydroxyproline, Plasma calcium, Laying hen

719 Development of an ELISPOT assay for monitoring chicken Follicle-Stimulating Hormone (cFSH) release from individual dispersed pituitary cells. N. Puebla-Osorio*¹, J.A. Proudman², H.H.M. Gerets³, F. Vandesande³, and L.R. Berghman¹, ¹Texas A&M University, College Station TX, ²USDA-ARS Beltsville, MD, ³University of Leuven, Belgium.

From a methodological point of view, FSH and thyroid-stimulating hormone (TSH), are among the most difficult pituitary hormones to study in most vertebrate species. The amount of hormone in the pituitary tends to be very small and the glycoprotein hormones themselves are complex molecules consisting of two non-covalently linked glycosylated subunits, only one of which is hormone-specific. The present study describes the development of a new cFSH ELISPOT assay, a hybrid between a sandwich ELISA and an immunodot assay. Pituitary cells from laying White Leghorn hens were gently dispersed using trypsin (1 mg/ml). In the meantime a nitrocellulose (NC) -bottomed 96-well filtration plate (Millipore, Bedford, MA), was coated with 1 mg monoclonal anti-cFSH, and then blocked with 0.5 % of BSA. The single cell suspension was counted and 50 ml of cell suspension, densities ranging from 1000 to 100,000 cells/ml, were seeded onto the NC bottoms. The cells were left to incubate overnight in the presence or absence of 50 mM KCl in DMEM medium containing 1 mg/ml of BSA. After incubation, the cells were removed and the FSH that had been captured in the spots immediately surrounding the cells was further detected using rabbit anti-chicken FSH α . The latter was then identified with a biotinylated secondary antibody and alkaline phosphatase-conjugated streptavidin. Visualization of the spots was attained with a final incubation with the substrate system NBT/BCIP. The NC discs were then air dried for microscopic evaluation of the frequency and diameter of the spots. Dark purple spots were observed with the smallest cell number, the spot frequency being proportional to the cell density. No spots were observed in the absence of cells and detection antibody, respectively. Also, KCl-stimulated cells produced markedly more and bigger spots. As soon as the quantitative analysis of the results has been developed, this tool can be used to evaluate cFSH secretion from individual pituitary cells under different physiological circumstances.

Key Words: chicken, FSH, ELISPOT

720 Dopaminergic neurotransmission controlling PRL/VIP secretion in the turkey. O.M. Youngren¹, Y. Chaiseha², S.E. Whiting¹, and M.E. El Halawani*¹, ¹University of Minnesota, St. Paul, MN, ²School of Biology, Institute of Science, Suranaree University of Technology, Thailand.

Vipergic neurons are the main element regulating avian PRL secretion. Our recent studies have demonstrated the modulation of VIPergic activity by stimulatory (via D₁ DA receptors) and inhibitory (via D₂ DA receptors) DAergic inputs. Dynorphin, serotonin (5-HT), DA, and VIP stimulate PRL secretion via a common hypothalamic pathway expressing κ opioid, 5-HTergic, DAergic, and VIPergic receptors, with the VIPergic system as the final mediator. Electrical stimulation (ES) within the turkey hypothalamus at the level of the medial preoptic nucleus (POM), the anterior hypothalamic nucleus (AM), the ventromedial hypothalamic nucleus (VMN), the infundibular nuclear complex (INF), and the median eminence (ME) results in the release of PRL. When the selective D₁ DA receptor antagonist SCH-23390 HCl was infused intraventricularly (icv) at the rate of 10 nmol/min, ES in POM, AM, and VMN was no longer able to increase PRL levels. Infusion of the D₁ DA antagonist did not prevent ES in ventral INF and ME from increasing PRL to the same level as that of controls. These results are interpreted to suggest that the D₁ DA receptors involved in PRL release lie caudal to VMN and dorsal to ventral INF. Electrical stimulation in POM, AM, or VMN appears to stimulate cells or fibers that release DA and this DA release is stimulatory for PRL secretion, whereas ES in INF and ME stimulates cells or fibers that release VIP directly to the pituitary. Microinjections of D₁ DA receptor agonist (SKF-38393 HCl, 50 ng, bilateral, n=5) into POM and VMN failed to produce any increase in PRL after 40 min, while microinjections in INF increased PRL from a baseline value of 40.8 \pm 4.7 ng/ml to 75.8 \pm 11.4 ng/ml after 15 min, reaching a high of 107.4 \pm 25.5 ng/ml 30 min after injection. This suggests that the only D₁ DA receptors involved in PRL release are located in the INF, the same area where changes in VIP neurons are known to occur throughout the reproductive cycle. USDA Grant No. 00-02127

Key Words: Turkey VIP, Avian Prolactin, Dopamine Receptor

721 Expression of D₁ and D₂ dopamine receptors in the hypothalamus and pituitary during the turkey reproductive cycle. Y. Chaiseha*¹, O.M. Youngren², S.A. Schnell³, and M.E. El Halawani², ¹School of Biology, Institute of Science, Suranaree University of Technology, Thailand, ²University of Minnesota, St. Paul, MN, ³University of Minnesota, Minneapolis, MN.

The regulation of avian prolactin (PRL) secretion and PRL gene expression is influenced by hypothalamic vasoactive intestinal peptide (VIP), the PRL releasing factor in avian species. Recent evidence indicates that D₁ and D₂ dopamine (DA) receptors play a pivotal role in VIP and PRL secretion. The differential expression of DA receptors on hypothalamic VIP neurons and anterior pituitary cells may affect the degree of prolactinemia observed during the turkey reproductive cycle. The relative expression of D₁ and D₂ DA receptor subtype mRNAs was quantitated using *in situ* hybridization histochemistry (ISH). The expression of D₁ DA receptor mRNA in the hypothalamus was found to be 6.8-fold greater than that of D₂ DA receptor mRNA. Higher D₁ DA receptor mRNA content was found in the anterior hypothalamus (3.6-fold), the ventromedial nucleus (2.0-fold), the infundibular nuclear complex (INF; 1.9-fold), and the medial preoptic nucleus (1.5-fold) of laying hens as compared to that of non-photostimulated hens. The levels seen in laying hens remained essentially the same in incubating hens, except for the INF area where levels increased 52%. During the photorefractory stage, the D₁ DA receptor mRNA was at its lowest level in all areas tested. No differences were observed in hypothalamic D₂ DA receptor mRNA abundance throughout the reproductive cycle. However, a marked reduction in pituitary D₂ DA receptor mRNA was observed in incubating hens. Pituitary D₁ DA receptor mRNA remained unchanged during the incubating phase. These results clearly demonstrate that the expression of stimulatory D₁ DA receptor mRNA in the hypothalamus increases in hyperprolactinemic incubating hens, whereas inhibitory D₂ DA receptor mRNA increases in the pituitary of hypoprolactinemic photorefractory hens. USDA Grant No. 00-02127

Key Words: *In situ* hybridization, Dopamine Receptor mRNA, Turkey Vasoactive intestinal peptide

722 Regulation of Prolactin Gene Expression by Vasoactive Intestinal Peptide and Dopamine: Role of Ca²⁺ Signaling. A. A. Al-Kahtane*¹, D. Deepak², M Kannan², and M El Halawane¹, ¹University of Minnesota - Department of Animal Sciences, ²University of Minnesota - Department of Veterinary Pathobiology.

It is well documented that vasoactive intestinal peptide (VIP) is the prolactin (PRL) releasing factor in avian species. Our previous study shows that dopamine (DA), through D-2 DA receptors on pituitary cells, inhibits the stimulatory effects of VIP on PRL secretion, PRL-mRNA steady state level, PRL transcription rate and PRL-mRNA half-life. In this study we examined: 1) the effects of VIP and DA D₂ receptor agonist (R(-)-propylnorapomorphine hydrochloride) on intracellular Ca²⁺ [Ca²⁺]_i in turkey primary pituitary cells, and 2) the involvement of extracellular Ca²⁺ in the regulation of PRL gene expression by VIP and DA. Fura-2 (Molecular Probes) was used as the fluorescent calcium indicator to measure [Ca²⁺]_i in turkey pituitary cells. Reverse transcription-polymerase chain reaction (RT-PCR) technique was used to determine PRL-mRNA levels. Measurement of [Ca²⁺]_i by Fura-2 indicated that VIP gradually increased [Ca²⁺]_i with all doses used (10⁻⁹ to 10⁻⁵M). Preincubating the pituitary cells with DA D₂ receptor agonist (10⁻¹⁰M) for 10 min. inhibited the stimulatory effect of VIP on [Ca²⁺]_i. Blocking Ca²⁺ influx by verapamil, an L-type Ca²⁺ channel blocker, diminished the stimulatory effect of VIP on PRL-mRNA level. In contrast, Bay K8644, an L-type Ca²⁺ channel agonist, mimicked the stimulatory effect of VIP on PRL-mRNA content. These results show clearly that: 1) the influx of extracellular Ca²⁺ is required for the stimulatory effect of VIP on PRL gene expression and PRL secretion in avian species, and 2) DA, via D₂ DA receptors, antagonizes the stimulatory effects of VIP on PRL-mRNA and PRL secretion at least by inhibiting the influx of extracellular Ca²⁺ in pituitary cells. This demonstrated the involvement of the Ca²⁺ signaling pathway in the dual regulation of PRL secretion and PRL gene expression by DA (inhibitory) and VIP (stimulatory) at the pituitary level. Supported by USDA grant #00-02127.

Key Words: VIP, Dopamine, Calcium

723 Characterization of the VIP response element (VRE) in turkey prolactin promoter. S.W. Kang^{*1}, S. You², E.A. Wong³, T. Bakken¹, and M.E. El Halawani¹, ¹Dept. of Animal Science, Univ. of Minnesota, ²Dept. of Animal Science and Technology, Seoul National University, ³Virginia Polytechnic Institute and State University.

We showed previously that vasoactive intestinal peptide (VIP) increases prolactin (PRL) gene expression and secretion in turkey primary pituitary cells. We have now used 5'-flanking deletions and mutations of the turkey PRL promoter fused to the luciferase (Luc) reporter gene in transient transfection assays to further characterize sequences involved in stimulation of PRL gene expression by VIP. Promoter activities were determined by quantitative RT-PCR of Luc mRNA. The deletion analysis of turkey PRL promoter (tPRLP) indicated that the VIP-stimulated tPRLP activity was controlled by three major positive regulatory regions and two negative regions. From the -127 to -14 Luc construct, where the 7-8 fold increase of promoter activity by VIP occurred, we did deletion assay with -92/-14 and -60/-14 Luc constructs for investigating the minimal VRE of the promoter. The 35-base pair (bp) segment (position -127 to -93) deletion induced complete suppression of VIP-stimulated promoter activity, suggesting that the nucleotides between position -127 and -93 in the tPRL promoter are essential for the VIP-stimulated promoter activity. A putative Pit-1 binding site was found in the middle of the 35-bp segment and the significance of this element (12 bp) was tested by Decoy assay, deletion, and mutation analysis. The result of the present study demonstrated that VRE (12bp) in the proximal prolactin promoter is an important cis-element for the VIP-stimulated PRL gene expression in turkey primary pituitary cells. USDA grant No. 00-02127 Key Words: Prolactin Promoter, Turkey VIP, Pituitary

Key Words: Prolactin Promoter, Turkey VIP, Pituitary

724 Met-enkephalin directly regulates the GnRH-I system in Japanese quail. MA Ottinger^{*1}, N Thompson¹, and P Micevych², ¹University of Maryland, ²UCLA Center of Health Sciences.

Studies in our laboratory have shown that met-enkephalin (ENK) is a powerful regulator of the GnRH-I system. We have demonstrated a dose dependent, ENK-inhibition of GnRH-I release in vitro (Chen and Ottinger, 1999; Poult Sci abstr. #293). Other studies have suggested that ENK-inhibition of GnRH-I release may be directly on GnRH neurons and indirectly, through interneurons. The current study was conducted to examine the anatomical relationship of ENK immunoreactive to the GnRH-I cell bodies and processes. Double-labeling immunocytochemistry revealed close anatomical proximity of ENK and sexual dimorphism in the GnRH-I system as well as in ENK innervation. Confocal

microscopy was used to determine if the ENK preferring delta opioid receptors occur on GnRH-I neurons, thereby providing a means for direct opiate regulation of the GnRH-I neuron. Fixed brains from adult males and females (n=6/group) were sectioned (20 μ m) and double stained using antibodies specific for GnRH-I (kindly provided by Dr. S. Wray, NIH) or δ -opioid receptor (Diasorin, Inc). Many, but not all, GnRH-I positive cells were also immunoreactive for delta-opioid receptor. Further, the distribution of double labeled cell bodies tended to be in the rostral preoptic-septal region. GnRH-I axonal projections to the median eminence were also double labeled. These data provide evidence for colocalization of opiate receptor in the GnRH-I neuron, indicating a mechanism for direct opioid peptide regulation of the GnRH-I neuron. Supported by NRI #92-37203 (MAO) and NS 39495 (PM).

Key Words: GnRH-I, Avian Reproduction, Opioid Peptides

725 Localization of neurons projecting to the infundibular nuclear complex and the median eminence in the turkey hypothalamus. K Al-Zailaie, O Youngren, and M El Halawani, Dept. of Animal Science, University of Minnesota.

The release of prolactin (PRL) from avian anterior pituitary is under stimulatory control by vasoactive intestinal peptide (VIP), which functions as the PRL-releasing factor. VIP is mobilized from neurons concentrated within the hypothalamic infundibular nuclear complex (INF) that project to the external layer of the median eminence (ME). Dopamine (DA) acts centrally through D1 DA receptors to stimulate turkey PRL secretion and requires an intact VIPergic system in order to do so. The mechanisms of dopaminergic action upon VIP neurons are unclear. We have previously demonstrated the distribution of dopaminergic neurons in the turkey hypothalamus. It is not known if these DA neurons project directly to VIP neurons or if transsynaptic regulation is involved. To address this question, we have used the lipophilic fluorescent tracer Dil to determine the location of neurons which project to INF and ME. Birds were injected in INF and ME with the tracer and allowed to survive for 5 days, after which the brains were perfused, processed, and examined for retrograde transport. Following application of Dil to the INF, labeled neurons were detected in four distinct regions: preoptic area (POA), paraventricular nucleus (PVN), preopticus dorsolateralis (PD) and lateral septum (LS). After injecting Dil into ME, labeled neurons were detected in three distinct regions: INF, PVN, and preoptic medialis. The projections described above could provide anatomical substrates for neuroendocrine regulation of PRL. The identification of these labeled neurons is currently under investigation. USDA Grant No. 00-02127

Key Words: DA regulation of VIP, Turkey PRL, Dil

Reciprocation Sessions on Meat Science

726 The MARC beef carcass image analysis system. S. D. Shackelford^{*}, T. L. Wheeler, and M. Koohmaraie, U.S. Meat Animal Research Center.

At present, beef carcass value is a function of USDA quality grade, a subjective estimate of meat palatability, and USDA yield grade, a subjective estimate of carcass composition. Although "expert" calculated USDA yield grade is a relatively accurate predictor of carcass composition, producers continue to distrust use of yield grade in pricing formulas because application of yield grades is subjective and a high level of error can occur when carcasses are evaluated at rates of 300 to 400 head per hour. In 1997, we developed a system to predict beef carcass cutability based on image analysis of the 12th rib cross-section which was removed from carcasses for tenderness classification. This method provided a more accurate prediction of beef carcass cutability than did "expert" calculated USDA yield grade ($R^2 = 0.89$ vs 0.77). The Agricultural Research Service entered into a cooperative research and development agreement with IBP, Inc. to adopt this technology for application directly to beef carcasses. On-line testing has shown that this system provides a much more accurate ($R^2 = 0.89$ vs 0.61) prediction of boneless closely-trimmed, "user-friendly" beef carcass yields than is currently achieved by on-line USDA graders. In fact, the MARC image analysis system provides a more accurate prediction of beef carcass yields than does expert calculated yield grade ($R^2 = 0.75$). The ability of this system to predict "expert" calculated USDA yield grade was

evaluated using 182 steer and 219 heifer carcasses that encompassed the typical range for carcass weight (227 to 455 kg), adjusted preliminary yield grade (2.2 to 4.7), ribeye area (57 to 132 cm²), and calculated yield grade (-0.3 to 5.1). Combining image analysis variables with hot carcass weight explained 88% of the variation in "expert" calculated USDA yield grade. Implementation of this technology should allow beef packers to more accurately determine differences among carcasses in cut-out value. Thus, this system should be a key component of value-based beef price discovery systems.

Key Words: Beef, Cutability, Prediction

727 Development of Instructional Materials for CD-ROM and the Internet, the Beef Myology and Muscle Profiling project. S.J. Jones^{*} and R.L. Roeber, University of Nebraska-Lincoln.

With the improvement of computers to handle graphic images and search through large databases rapidly, it is now possible to develop a CD-ROM or web page that will serve as a resource for the muscular anatomy of the beef animal. With funding from the National Cattlemen's Beef Association, a CD-ROM was developed on beef myology and muscle profiling. Six different sections were developed to view the muscular and skeletal anatomy of the beef carcass; they included cross-sections, lateral views, sub-primal views, skeletal views and muscle and bone descriptions by

name. Photographs of 1" cross-sections of each wholesale cut was obtained and converted to JPEG format. A second beef side was laterally dissected with the removal of fat and individual muscles removed and photographed along with the carcass. Drawings in GIF format were developed for each picture. Sub-primal cuts were prepared and photographed on a rotating table every 22.5 degrees so all sides of the cut could be viewed. Information about each muscle was obtained and put into a database. The program was rendered using hypertext markup language (HTML). Application logic was written in JAVA so information is presented to a reader using an internet browser as the user interface and allowing the information to be shared. Flash animations were utilized to give the user a three dimensional view of sub-primal cuts. Utilization of computer technology helped to develop a beef myology and muscle profiling manual that can be updated rapidly and accessed world wide through the internet.

Key Words: CD-rom, Beef Myology, Internet

728 Bacon quality evaluation methods. Roger Mandigo*, *University of Nebraska-Lincoln.*

This Reciprocation session will address a variety of techniques and procedures used in the evaluation of sliced bacon. Some of the procedures to evaluate bacon to be discussed include: Camera Visioning and Computer Data Capture for Fat/Lean Quantity, Fat/Lean Color Classification System, Color of Pre-cooked Bacon, Slice Abnormalities, Shattering, Laciness, Length/width of slice, shrinkage during cooking, cooked slice distortion. Other techniques for discussion include: bacon slab firmness, where to measure, how to measure slab parameters, temperature at pressing/slicing and fatty acid profiles.

Key Words: Bacon

729 "Meal Solutions": Value added processing for a changing industry. J.W. Rocke*¹, ¹*RMH Foods, Inc.*

The dramatic growth of the "Meal Solutions" Category at both Retail and Food Services is signaling the shift from a commodity, fresh meat driven industry to a Value Added, consumer driven industry. This shift is requiring new technologies, processes and approaches to products that were once considered out of date or undervalued. Food Safety, Quality Eating Experiences and Variety are a few of the challenges that must

be addressed by processors to meet and exceed the desire of today's consumer.

730 A potential neural tract-tracing method for use in avian species. W.J. Kuenzel*¹, R. Ramesh², J.A. Proudman³, and R.R. Miselis⁴, ¹*University of Arkansas, Fayetteville, AR*, ²*National Institutes of Health, Bethesda, MD*, ³*United States Department of Agriculture, Beltsville, MD*, ⁴*University of Pennsylvania, Philadelphia, PA.*

Turkey hens display broodiness or incubation behavior involving contact of the breast area with eggs. The purpose of the study was to utilize a method found effective in mammals for tracing neural fiber tracts to determine whether it might be applicable for tracing a pathway from the brood patch to the brain in turkey hens. The method employed was the pseudorabies virus (PRV, Becker's strain) procedure. Four turkey hens were utilized: one injected with PRV along the left side of the brood patch near nerve fibers, a second bilaterally injected, a third injected into the left vitreous humor and a fourth served as a control. The concentration of PRV was 4-7 x 10⁸ plaque forming units/ml and the amount injected at each site was 5.0 µl. Brain sections were exposed to a polyclonal antibody to PRV (1:10,000) and subsequently processed using immunocytochemistry. Results of the bilateral injection into the brood patch showed immunostaining in the nucleus tractus solitarius, the dorsal motor nucleus of the vagus, the nucleus vestibularis descendens, the ventrolateral medulla and the nucleus reticularis gigantocellularis. Results of the injection into the vitreous humor included immunostaining of two portions of the proposed suprachiasmatic nucleus (SCN) of birds: the SCN pars medialis and the ventral nucleus of the supraoptic decussation. Other neural structures immunostained included the anterior, medial hypothalamic nucleus (n.), the bed n. of the pallial commissure, the paraventricular n., the lateral hypothalamic area, the inferior hypothalamic n., the n. of I, the archistriatum, the intercollicular n. and the central gray. A caution concerning the use of PRV in birds is that the immunostaining was not robust, particularly when brain sections were compared to those performed in rats following injection of Bartha's K strain of PRV into a peripheral injection site. The reason for the reduced number of neurons that show immunoreactivity following injections of PRV into hens compared to the rat is not known. Supported by USDA grant 97-35206-5087 to JAP and WJK.

Key Words: Pseudorabies virus, brain, turkeys

Applications of Ultrasound in Livestock Production Systems

731 Scanning the future - Ultrasonography as a reproductive management tool for dairy cattle. P. M. Fricke*, *University of Wisconsin, Madison, Wisconsin.*

Application of transrectal real-time ultrasonography to the study of bovine reproduction represents a technological breakthrough that has revolutionized our knowledge of reproductive biology. New research information generated through ultrasonic imaging has clarified the nature of complex reproductive processes in cattle including ovarian follicular dynamics, corpus luteum function, and fetal development. Widespread adoption and use of ultrasonography for routine reproductive examinations of dairy cattle is the next contribution this technology will make to the dairy industry. Although rectal palpation is the established method for conducting reproductive examinations in dairy cattle, the information-gathering capabilities of ultrasonic imaging far exceed those of rectal palpation. Assessment of pregnancy status and fetal viability early post breeding to identify cows that fail to conceive improves reproductive efficiency by decreasing the interval between AI services and increasing AI service rate. Early identification of cows carrying twin fetuses allows for implementation of differential management strategies to abrogate negative effects of twinning during the periparturient period. Ovarian and uterine pathologies not accurately detected via rectal palpation can easily be visualized and appropriate therapies selected and implemented. Determination of fetal sex in utero is useful when coupled with a management decision that justifies the expense of fetal sexing. Development of integrated reproductive management systems that combine ultrasound with new and existing reproductive technologies will further enhance the practical applications of ultrasonography. Collectively, current and future applications of ultrasonography hold tremendous potential to enhance reproductive management and improve reproductive efficiency in dairy cattle. Development of Extension education

programs to train bovine practitioners to use ultrasound for routine reproductive examinations is a critical step toward rapid implementation of this technology into the dairy industry. As ultrasound equipment becomes increasingly portable and less costly, it is only a matter of time until widespread implementation of this technology occurs in the dairy industry.

Key Words: Ultrasound, Dairy Cattle, Reproduction

732 Ultrasound applications in beef cattle research and management. A.R. Williams*, *Mississippi State University, Starkville, MS.*

The advent of real-time, B-mode ultrasound has greatly facilitated and accelerated research capabilities in the areas of bovine reproductive physiology and live animal carcass evaluation. The incorporation of ultrasound in bovine reproductive research has led to greater understanding of ovarian physiology, early embryonic development, follicular wave dynamics, and reproductive disorders. Ultrasound has been used extensively in the development of controlled breeding programs involving estrus synchronization and ovulation synchronization for effective timed AI. Practical applications of ultrasound in bovine reproduction include imaging of the ovary as a diagnostic aid, examination and confirmation of ovarian cysts, early pregnancy detection, fetal sex determination, and identification of twins. More specialized reproductive applications include follicular oocyte aspiration (ovum pickup) and follicle ablation. Live animal carcass evaluation is another important area of research. Recent advancements in carcass image interpretation software have allowed for highly accurate estimates of ribeye area, backfat, percent intramuscular fat, and rump fat. Ultrasound measurements are

being used to gather data for genetic evaluations in breeding and feedlot cattle. Instead of relying on progeny testing based on the collection of actual carcass data, beef sires are being evaluated at a younger age with a high degree of accuracy. Several breed associations are currently using ultrasound data to estimate carcass EPDs. Research has indicated ultrasound is effective in sorting cattle in the feedlot for more optimum finishing and sorting prior to feeding. The future of carcass ultrasound includes continued update of current software system models and algorithms, development of an automated software package, and potential use in identifying factors determining tenderness. Practical applications of ultrasound in the beef industry will become normal practice in the near future. Data generated will have a positive impact on both reproductive efficiency and carcass quality.

Key Words: Beef Cattle, Ultrasound, Applications

733 Evolution and use of ultrasonic technology in the swine industry. S.J. Moeller*, *The Ohio State University, Columbus OH.*

The use of ultrasound to measure biological tissue dates back to at least 1950 (Wild, 1950), with early ultrasonic work focusing primarily on human medicine. The application in livestock species was somewhat slow due to the cumbersome, fragile machines and high investment costs. Historically, the application of ultrasound to swine has focused upon composition and reproductive status assessment, with most of the research carried out through universities and land-grant institutions. Hazel and Kline (1959), Price et al. (1960), and Stouffer et al. (1961) using various ultrasonic systems were among the first to report results relating ultrasound readings with carcass measures of composition. However, the accuracy of the early amplitude-depth (A-mode), single-crystal devices was often quite variable. The introduction of B-mode (brightness modality) ultrasound, using multiple-crystal transducers and displayed in real-time (RTU) greatly enhanced the accuracy of live animal composition evaluation (Alliston et al., 1982; Forrest et al., 1986; Turlington et al., 1990) and provided an understanding of extraneous effects on accuracy of measurements. In 1993, the U.S. swine industry implemented a national ultrasound training and certification program for composition assessment on live swine. Early research in the reproduction area utilized Doppler ultrasound systems that measured fluid flow within the uterus (Fraser et al., 1968, 1971). A-mode systems were evaluated by

Lindahl et al. (1975) and Hansen and Christensen (1976). Doppler and A-mode devices, while relatively inexpensive and accurate within specified time frames during gestation, are less accurate than RTU. Research indicates RTU is an accurate system of pregnancy detection as early as 22 d after first mating (Inaba et al., 1983; Jackson, 1986; Almond and Dial, 1987). Enhanced technology, increased portability and reduced cost have allowed ultrasound to be a common tool used in swine units, packing plants and research institutes. Future research in the areas of composition, muscle quality, and reproductive biology, along with enhanced imaging capabilities, will lead the way to new, innovative applications.

Key Words: Swine, Ultrasound, Composition

734 Ultrasound as a tool to assess reproductive status in poultry. J.D. Kirby*, R.W. Rorie, V. Melnychuk, and N.B. Anthony, *University of Arkansas, Fayetteville, AR 72701.*

Ultrasound has been used to evaluate reproductive status in humans and other mammals for many years. In the domestic fowl, the primary reproductive organs of both sexes are completely internalized making visual evaluations of reproductive status difficult. Additionally, due to the low relative value of each individual hen or rooster in an integrated production and management system there has been little effort to evaluate the reproductive performance of individuals, resulting in group management schemes. Over the past few decades, the genetic resources used to develop production parent stock has been consolidated into a limited number of elite lines owned by only a few companies. These companies use intense selection, typically only the top 0.1 to 10% are retained, to produce the elite "pedigreed" breeding stock. These elite breeders are then used to develop multiplier great- and grandparent populations. Due to the potential fecundity of poultry, pedigree males and females can ultimately be responsible for many millions of pounds of product produced. We have been able to use ultrasound to assess reproductive potential, primarily in hens, of broiler breeder and layer type chickens. Our results suggest that ultrasound can be used as a tool for selecting individuals with well formed, normal, follicular hierarchies or, in males, testis development. The potential for application in domestic or threatened bird species is tremendous and merits further evaluation.

Key Words: ultrasound, poultry, reproduction

Bioethics in Animal Science

735 Applied ethics and animal science. W.R. Stricklin*¹ and Lars Vikinge*², ¹*University of Maryland*, ²*Center for Applied Ethics, Linköping University, Linköping, Sweden.*

Animal agriculture is currently confronting many issues that range across a wide spectrum of public opinion. Environmental issues, animal treatment, gene manipulation, food safety, declining farm numbers, changes in rural society, and farm and food worker labor issues are but a few areas where there are valid differences of opinion relative to ethical questions involving animal agriculture. The response to these issues by animal scientists of course varies among individuals. However, we suggest that a somewhat common view by scientists is of the following type, "I only deal with facts. Science tells me everything I need to know. Philosophy is simply words related to opinion where one can not collect data and establish facts." We contend that values are an unavoidable part of all human decision-making, including for instance choices of research focus in science. We further contend that the methods for moral reasoning used by applied ethicists have many similarities to the scientific process. While we acknowledge that not everyone using this process will always reach the same conclusion, we contend that this is also true for the scientific method. Ultimately, if animal scientists are to serve the needs of animal agriculture as they contend is their mission, then they have an obligation to address the issues that are confronting animal agriculture. The challenge then becomes a matter of seeking methods for beginning the establishment of consensus in a pluralistic society. We will argue that the tools used by applied ethicists can be useful in the pursuit of this consensus. Not necessarily each animal scientist should take on this endeavor, but we propose that it should be a supported activity of at least some. These individuals must expand their knowledge base to include some familiarity of philosophy and arm themselves with additional academic tools other than those of science. Specifically, to increase their effectiveness, they must become somewhat conversant in

the methodology of moral philosophy and then work toward the development of collaborative efforts with applied ethicists. And finally, the leadership of the discipline of animal science should work toward facilitating the dissemination of knowledge regarding applied ethics and the process of consensus building.

Key Words: Applied ethics, Animal agriculture, Bioethics

736 Postmodernism for animal scientists. K.K. Schillo*¹ and P.B. Thompson*², ¹*University of Kentucky, Lexington, KY*, ²*Purdue University, West Lafayette, IN.*

Our goal is to explore whether postmodernism, a popular perspective within the humanities and social sciences, is relevant to animal science in the context of addressing contentious policy issues. As a social institution in Western culture, the animal science profession favors a modern ideological perspective. This view, which emerged in the 16th century and developed into the 19th century, is characterized by several pivotal assumptions: 1) humans are essentially rational individuals; 2) science is the paradigm of rationality and is therefore the most legitimate source of knowledge; 3) change brought about by science-based technology is inherently progressive. During the last century, there has been growing criticism of modernism. For example, a number of groups question the claim that science is an objective practice and view technology in terms of creating unnecessary risks rather than serving a social good. Such criticisms have been attributed to postmodernism. In general, postmodern theorists emphasize the role of language as a means to explain reality, and argue that because language is both historically and culturally relative, no one account of reality can be purely objective. In this sense, postmodernism has often been characterized as "anti-scientific." Some varieties of postmodernism embrace a nihilistic perspective and

portray scientific knowledge as nothing more than personal preferences that don't matter. However, other varieties view science as a value-laden social practice, but recognize that scientific methods can provide useful ways for coping with nature; especially when they take into account multiple perspectives. It is this latter view that offers insight into how the animal science profession can address policy issues in morally responsible ways. Currently, the animal science community advocates the modern view that public policy should be based only on sound sci-

ence. This view conceives the animal science community as one that is segregated from and holds authority over a greater human community. A perspective which seems more compatible with addressing the diverse interests of a greater community is one which views animal scientists as part of such a community, and who provide only some of the perspectives that should be considered when addressing policy issues.

Key Words: Ethics, Policy, Philosophy of Science

Mechanisms of Hormonal Signal Transduction

737 Progesterone regulates reproductive function through two functionally distinct receptor isoforms. OM Conneely*¹, B Mulac-Jericevic¹, and F DeMayo¹, ¹*Baylor College of Medicine.*

Progesterone regulates reproductive function by interaction with two intracellular receptors, PR-A and PR-B, that arise from a single gene. To establish the selective physiological roles of PR isoforms in vivo, we have selectively ablated PR-A (PRAKO) or PR-B (PRBKO) expression in mice. Ablation of PR-A results in severe abnormalities in ovarian and uterine function but does not affect responses of the mammary gland or thymus to progesterone. Analysis of uterine function of PRAKO mice reveals an unexpected progesterone-dependent proliferative activity of PR-B in the epithelium and provides evidence that the tissue specific functions of this isoform are due to specificity of target gene transactivation rather than differences in spatiotemporal expression relative to PR A. Contrary to PRAKO mice, PRBKO mice are fertile and have successful pregnancies that result in normal litter sizes. Histological studies of uteri isolated from PRBKO mice revealed normal sensitivity to estrogen and progesterone. Specifically, progesterone acting through PR-A alone antagonizes estrogen-induced proliferation of the uterine epithelium in PRBKO mice. Progesterone receptors are critical for mammary gland development and morphogenesis. We have analyzed mammary glands response to estrogen and progesterone in PRBKO animals ovariectomized at 6 or 10 weeks of age. Whole mounts analysis of mammary glands obtained from ovariectomized 6 week old PRBKO mice treated with estrogen and progesterone for 3 weeks showed significantly reduced side branching when compared to wild type and PRAKO mice. Interestingly this phenotype is reverted in 10 week old PRBKO mice treated under identical hormonal regime. These results further demonstrate tissue specific functions of progesterone receptor isoforms.

Key Words: progesterone receptor isoforms, female reproduction

738 Role of Neurotrophic Factors in Ovarian Development. S.R. Ojeda*, G.A. Dissen, C. Romero, and A. Paredes, *Oregon Regional Primate Research Center/Oregon Health Sciences University, Beaverton, OR.*

The neurotrophins nerve growth factor (NGF), neurotrophin-4/5 (NT-4/5), and brain derived neurotrophic factor (BDNF), and their high-affinity tyrosine kinase membrane-anchored receptors (trkA for NGF and trkB for NT-4/5 and BDNF) are expressed in the mammalian ovary before the initiation of follicular assembly. Mice carrying a null mutation of the NGF gene had a reduced number of primary follicles and a normal population of primordial follicles, suggesting that NGF is not required for follicular formation, but is necessary for the initiation of follicular growth. The fewer primary follicles seen in NGF KO mice appear to result from a deficiency in somatic ovarian cell proliferation. After formation of primary follicles, NGF facilitates early follicle growth by inducing the synthesis of biologically active FSH receptors. Concomitant

deletion of the NT-4 and BDNF genes, or deletion of the gene encoding their trkB receptor, resulted in reduced granulosa cell proliferation and decreased formation of secondary follicles at the onset of follicular growth. Thus, activation of trkA receptors during early follicle development appears to sustain the conversion of primordial into primary follicles, whereas activation of trkB receptors facilitates the acquisition of additional layers of granulosa cells by the primary follicles. Thecal cells of antral follicles continue to express NGF and respond to the neurotrophin with proliferation and prostaglandin release. While an increase in thecal trkA expression occurs at the time of the preovulatory surge of gonadotropins, blockade of trkA receptors inhibits ovulation, suggesting a role for NGF in ovulatory rupture. Thus, neurotrophins contribute to regulating two key phases of ovarian development: the initiation of follicular growth, and follicular rupture at ovulation. Together, these results identify a novel function for the neurotrophins in the development of a nonneural organ, and demonstrate that they act in the ovary to facilitate the proliferation and differentiation of specific cellular subsets involved in follicular growth. (Supported by NIH grants HD-24870, RR-00163 and U54-HD18185)

Key Words: Ovarian Development, Neurotrophic Factors, Follicular Growth

739 Growth hormone signaling to the nucleus. Jessica Schwartz* and Graciela Pivien-Pilipuk, *Dept. Physiology, University of Michigan.*

Effective use of growth hormone (GH) depends on understanding its mechanism of action. The diverse actions of GH are mediated by multiple signaling mechanisms. When GH binds, the GH receptor associates with the tyrosine kinase JAK2, initiating multiple signaling events. Analysis of GH-regulated gene expression indicates that multiple signaling cascades triggered by GH regulate the function of multiple transcription factors. The proto-oncogene c-fos is a target for several GH-initiated signaling pathways. One pathway, mediated by GH-promoted tyrosine phosphorylation of Signal Transducers and Activators of Transcription (STATs), regulates the *Sis-Inducible Element*. Transcriptional activation mediated by the Serum Response Element in response to GH depends on the phosphorylation and activation of the transcription factor Elk-1 by MAP kinases. The dephosphorylation of the transcription factor C/EBP beta promoted by GH appears to reflect inhibition of Glycogen Synthase Kinase 3 (GSK3) via GH-stimulated PI-3 kinase/Akt, leading to changes in the binding and function of C/EBP beta. It is likely that signaling networks involving multiple pathways initiated by GH-GH receptor-JAK2 interactions contribute to the coordinated regulation of gene expression in response to GH. Such changes in gene expression underlie the physiological actions of GH.

Key Words: Gene expression, GH signal transduction, Transcription factors

Profitable Meat Goat Production: The Interaction of Genotype and Management

740 Rheological characteristics of uncooked goat meat. Eric Risch* and Jackson M. Dzakuma, *Prairie View A&M University, Prairie View, TX. USA.*

After weaning, 48 kids of Spanish (SP) and Tennessee Stiff-Legged (TS) breeds were individually penned and fed an 18% CP and 65% TDN ration for six months during which time their weights were taken on a bi-weekly basis. These breeds represent goats with small (TS) and intermediate (SP) mature sizes. They were slaughtered at six months of age. Four replicates of rectangular slabs (approximately 2.54 cm x 2.54

cm x 1.77 cm) of samples were taken from the fore-quarter, hind-quarter and breast regions of the carcasses. An Instron Universal Testing Machine (Model 4201) was used to apply 80 % compression deformation at a strain rate of 2.54 cm/min to each sample in the axial direction. The strength or ultimate stress (as determined by the ultimate load applied to the sample till failure), the elastic modulus (as determined by the ratio of ultimate stress over strain) and the toughness of the sample (derived from the area under the force-deformation curve and giving an indication of the energy required to propagate failure) were determined

by measurement or calculation. For the three properties measured (*Ultimate Stress (ULTSTRESS), Elastic Modulus and Toughness*) these assumptions were made: Samples were homogeneous and isometric. Results indicated that no differences ($P > .05$) were observed in the three properties measured for main effects of breeds. For sex main effects, statistically significant differences ($P < .01$) were observed in all three properties: ULTSTRESS (67.7 vs 46.5 kg/m²); Modulus (422.7 vs 286.1 kg/m²); Toughness (9.9 vs 7.1 kg-m/m³) for females and males, respectively. Between the two breeds at the same dietary levels, statistically significant differences ($P < .05$) were observed. For example, between SP and TS, respectively: ULTSTRESS at 70% level (72.8 vs 34.7 kg/m²) and at 85% level (40.5 vs 77.2 kg/m²); Modulus at 70% level (429.6 vs 192.1 kg/m²) and at 85% level (274.5 vs 481.9 kg/m²); and for Toughness at 70% level (11.7 vs 5.12 kg-m/m³) and at 85% level (5.2 vs 12.2 kg-m/m³). The results would seem to indicate that the level of the feed intake affects the rheological characteristics of goat meat. This would tend to influence consumer acceptance of goat meat and meat products which depends on perceived textural properties of the product.

Key Words: Goat, Rheological, Modulus, Toughness, Ultimate Stress

741 The impact of breed and management on market and carcass value. Louis Nuti^{*1}, Frank Pinkerton², and Ken McMillin³, ¹*Prairie View A&M University*, ²*The Goat Works*, ³*Louisiana State University Agricultural Center*.

Meat producers are faced with many management decisions and necessarily choose among several options concerning breeding, feeding, health and marketing programs. Historically, Spanish and Angora goats have been the breeds of choice, primarily due to the numbers available. Year round grazing on brush and perennial grasses with minimal protein and energy supplementation have long been the norm. Slaughter goats have usually been marketed via auctions, traders and private treaty, with producers typically having little recourse and even less knowledge of marketing channels, supply and demand. The recent advent of Boer goats from South Africa and other meat goat breed types pose a number of questions for traditional meat goat producers. Such questions as, will Boer and other crosses grow more efficiently, grow faster and be more readily accepted and be more valuable than currently available slaughter animals? The objectives of this project were to: 1) determine production responses of meat goat breeds to different feeding regimes; 2) determine auction barn responses as influenced by breed, grade and management; 3) compare relative 'profitability' of breeds as influenced by management; and, 4) compare carcass qualities. Previous confinement feeding trials have shown that feed conversions (kg feed/kg gain) at current levels of feed cost (\$0.10-\$0.12/pound) and current market prices for goats (\$0.70-\$0.80 per cwt) were not practical. Trials using native or improved pastures, with or without supplementation did show a significant positive growth response ($P < 0.05$) when cross bred Boer wethers were supplemented with 0.45 kg corn/hd/day. This group of wethers also graded higher live and yielded a higher auction barn price per pound. The net effect was to show an improvement in income-over-supplemental feed cost by Boer crosses. This advantage over Spanish wethers was apparently due to: 1) larger A.D.G.; 2) better live grades; 3) increased price/lb of sale weight. The carcass data suggests that the real advantage to breed and supplementation was that the heavier carcasses yielded higher ($P < 0.05$) weights of total cuts for the same age animals.

Key Words: Meat goats, Management, Economics

742 The economic implications of genotype by nutrition interactions in goats raised for meat. Will R. Getz^{*}, *Georgia Small Ruminant Research & Extension Center, Fort Valley State University, GA.*

Resources used for goats in meat production systems are numerous and varied. Among the most costly are nutrient resources. Costs of energy and protein are associated with land value, agronomic practices, and purchased supplements. Animal genotype determines potential growth rate, milk yield, muscle development, and mature size. Growth, milk yield, reproduction and mature size determine nutrient requirements for maintenance and production. As genotype changes so do nutrient requirements. Systems of goat meat production are dynamic and diverse. They are impacted by biological, economic, and social factors. The combination of these factors is best analyzed holistically. Although

some useful and interesting work has occurred with sheep, the literature for goats is relatively thin. With this in mind we have undertaken to give due consideration to the interactions to be factored in optimizing systems when reviewing existing frameworks and testing new configurations. This paper seeks to highlight several of the factors which suggest existing interactions. Product output per unit of nutrient input involves a complex of relationships. Improvements in productivity may not result in improvement in efficiency or profitability. Resources used and production level attained can best be expressed in terms of value added to the final product, and returns to labor, land and capital. Those which are site specific tend to be less diverse but the impact of interactions suggests that what we know about main effects must be tempered by knowledge of the nutritional environment. Recent availability of genotypes with suggested higher production and more desirable product form, require that cost-benefit relationships be revisited. Maintenance requirements, prolificacy and fecundity, weight gain and competition from internal parasites are all factors that enter the productivity equation and impact on profit conscious breeders and meat producers. Where changes in genotype bring about different results under two or more nutrition environments then interactions are real and must be considered in any economic analysis.

Key Words: Goat, Economic implications, Genotype nutrition interactions

743 Goat growth in relation to feed intake. H. Blackburn^{*1}, J. Dzakuma², and A. Goetsch³, ¹*USDA-ARS*, ²*Prairie View A&M University*, ³*Langston University*.

Growth and growth efficiency are complex functions mediated by genetics, nutrient quality, intake level, maturing patterns and environmental factors. Using Tennessee Stiff-legged (TS) and Spanish (SP) breeds growth, body composition, feed intake and feed efficiency were evaluated from weaning to 1 yr of age when fed ad libitum or at 85 or 70% of ad libitum intake. Twenty-four animals of each breed, with equal numbers of different genders, were individually penned and fed a diet consisting of 18% CP and 65% TDN. Feed intake was measured daily and body weight was determined every 14 d. At 6 mo of age, cumulative feed intake for TS and SP breeds, respectively, was 50.5 and 51.3 kg; and growth weights was 18.6 and 19.1 kg. From 10 to 13 mo of age, cumulative feed intake for the same breeds, respectively, was 66.6 and 67.7 kg, and 13-mo growth weight was 25.9 and 26.1 kg. No differences ($P > 0.01$) existed in feed intake and growth weights despite the differences in mature sizes (TS = 36.8 and SP = 47.5 kg), implying that the TS were more efficient ($P < 0.05$) in converting feed into weight gain. The TS gained 0.167 kg per kilogram of feed consumed, compared with 0.122 for SP. The Brody growth equation was fitted to growth data of the TS and SP populations. Analysis yielded the same maturing rate (0.00268) for the two breeds. Maturing rate describes the rate at which an animal achieves its mature size. Animals with different mature sizes (e.g., TS and SP) should have different maturing rates. These results demonstrate TS had the same maturing rate as SP, a larger breed. Such a result implies TS is growing more efficiently than SP, confirmed by feed efficiency and average daily gain calculated on these goats. To more fully evaluate the above data a simulation model was used to compare our understanding of the integration of growth, nutrient partitioning, and feed intake. There were deviations between live animal and simulated data for portions of growth, feed intake, and body composition. These deviations represent an incomplete understanding of the growth process and provide a basis for designing focused experiments to better elucidate our understanding.

Key Words: Goats, Growth, Feed efficiency

744 Isolation and identification of proteolytic psychrotrophic bacteria from raw milk. Ahmed S. Zahran*¹ and Bruce F. Ward², ¹Minia University, ²University of Edinburgh.

A large number of bacteria secrete extracellular proteases, lipases and phospholipases into the external medium. The presence of these enzymes cause problems for the dairy industry. Proteases for example produce bitterness, gelation of UHT milk and decrease in the keeping quality of milk during the manufacture of cheese and other dairy products. Eight genera of protease producing psychrotrophic bacteria were isolated from raw milk. Four genera were found to be Gram-positive and four were Gram-negative. The Gram-positive genera were *Bacillus*, *Micrococcus*, *Corynebacterium* and *Staphylococcus*. The Gram-negative bacteria were *Flavobacterium*, *Pseudomonas*, *Acinetobacter* and *Cytophaga*. *Flavobacterium* spp and *Pseudomonas* spp were the two main genera, they represented 48.8 and 34% respectively. *Pseudomonas* spp were more active in terms of protease production than *Flavobacterium* spp. Five different *Pseudomonas* species were identified, they were *P. fluorescens*, *P. putida*, *P. aeruginosa*, *P. diminuta* and *P. vesicularis*. *P. fluorescens* was the dominant species, it represented 42.9% of the *Pseudomonas* species isolated. All the isolated *Pseudomonas* showed polar flagella when examined by transmission electron microscopy. Strain 8 synthesized the enzyme in basal and complex media. The amount of protease secreted (activity/growth) in complex medium was higher than that produced in basal medium.

Key Words: Proteolytic, Psychrotrophic, raw milk

745 Survival of a five strain cocktail of *E. coli* O157:H7 during the 60 Days Aging Period of Hard Cheese Made from Unpasteurized Milk. Joseph Schlessner*¹, Kevin Madsen², and Robert Gerdes², ¹Food and Drug Administration, NCFST, Summit-Argo, IL, ²Illinois Institute of Technology, NCFST, Summit-Argo, IL.

Hard cheese was made from unpasteurized milk inoculated with 10⁵ cells/ml of a five-strain cocktail of *E. coli* O157:H7 (*E. coli* O157:H7 43895, *E. coli* O157:H7 SEA 13B88, *E. coli* O157:H7 932, *E. coli* O157:H7 C7927, and *E. coli* O157:H7 ENT 9490). Samples of unpasteurized milk, curd and whey were collected during the cheese manufacturing process. After pressing, the blocks of hard cheese were packaged into plastic bags, and sealed with a vacuum-packaging machine, and aged at 7 ° C. After 1 week, the cheese blocks were cut into smaller uniform-sized pieces, and vacuum sealed in clear plastic pouches for ease of sampling at the various aging intervals. Samples were plated and enumerated for *E. coli* O157:H7 using BCM for *E. coli* O157:H7 (+) Plating Medium; and plate count agar for total plate count enumeration. Populations of *E. coli* O157:H7 increased to 10⁶ cells/gm in the drained curd and to 10⁷ cells/gm at milling and pressing. Populations of *E. coli* O157:H7 in cheese aged for 60 and 90 days at 7 ° C were reduced by 1-log and 1 to 2-logs, respectively. Populations of *E. coli* O157:H7 in cheese aged for 180 and 240 days at 7 ° C were reduced by 2-log and 3-logs, respectively. Cheese was also made from unpasteurized milk inoculated with 10³ cells/ml of a five-strain cocktail of *E. coli* O157:H7. Populations of *E. coli* O157:H7 increased to 10⁴ cells/gm in the drained curd and at milling and to 10⁵ cells/gm at pressing. Preliminary results shows no change in population at 60 days of aging at 7 ° C.

Key Words: aging, hard cheese, survival of pathogens

746 Production of an exopolysaccharide-containing whey protein concentrate by fermentation of whey with *L. delbrueckii* ssp. *bulgaricus* RR. E. M. Panko* and R. F. Roberts, Pennsylvania State University.

About 22 million metric tons of whey is produced annually in the U.S. Approximately half is manufactured into whey protein concentrate (WPC); the remainder is considered a waste stream. Using whey as a fermentation media presents the opportunity to create value-added products. Fermentation of whey with exopolysaccharide-producing (EPS⁺) bacteria may result in WPC with unique functional attributes. However, exopolysaccharide-producing lactic acid bacteria are weakly proteolytic, and the amount of low molecular weight nitrogen in whey is limited. Conditions were developed to partially hydrolyze the whey

proteins and then ferment the product with EPS⁺ bacteria. In preliminary experiments, pasteurized Cheddar cheese whey was treated with FlavourzymeTM to partially hydrolyze the protein (%DH 2-12). Fermentation (38°C, pH 5.0) with *L. delbrueckii* ssp. *bulgaricus* RR revealed that hydrolysis increased the amount of EPS produced from <5 to ca. 400 mg/L. Furthermore, low levels of hydrolysis resulted in EPS levels similar to high levels of hydrolysis. In scale up experiments, whey was separated and pasteurized, then hydrolyzed to 2% DH with FlavourzymeTM. Following protease inactivation, 60 L of partially hydrolyzed whey was fermented at 38°C, pH 5.0. After fermentation the broth was pasteurized, bacterial cells were removed using a Sharples centrifuge, then the whey was ultrafiltered and diafiltered (10,000 mwco) to remove lactose and salts, freeze-dried and milled to a powder. Unfermented hydrolyzed and unhydrolyzed whey controls were processed in the same manner. The EPS-WPC ingredients contained approximately 72% protein and 6% EPS. The whey-EPS blends exhibited low protein solubility (70%, pH 7.0) and extensive protein denaturation. The ingredient (2% protein) formed stable gels (G' increased from 0 to 10⁴ Pa) upon heating to 85°C. Fermented whey ingredients exhibited gelation onset at lower temperatures than the control whey (65 vs. 80°C). Partial hydrolysis of whey, followed by fermentation by an EPS-producing bacteria and downstream processing, produced functional whey-based ingredients.

Key Words: exopolysaccharide, whey protein concentrate, *Lactobacillus delbrueckii* ssp. *bulgaricus*

747 Continuous production of antimicrobial compound(s) and organic acids by bifidobacteria cells entrapped in sodium alginate beads. Z. Morrison, S.A. Ibrahim, M.M. Salameh, A. Shahbazi, and C.W. Seo, North Carolina Agricultural and Technical State University.

Whey contains high quantity of lactose and other nutrients, which can be easily utilized by lactic acid bacteria and probiotics to produce organic acids and value added products. Therefore, the objective of this research was to evaluate the technical feasibility of producing antimicrobial compound(s) and organic acids (lactic and acetic acids) from whey and high lactose media using a continuous fermenter inoculated with *Bifidobacterium* sp. (B-1-2) cells entrapped in sodium alginate beads. Immobilized beads were packed in a column for continuous fermentation using 1-liter Lactose MRS broth (4% lactose, 1.5% MRS, 0.005% MnSO₄ and 0.01% Tween 20) or whey-based medium. The broth medium was placed inside a round flask sitting in a water bath (37.5 °C), and fed to the bottom of the bead column using a peristaltic pump. Samples collected at different time intervals during the fermentation period were analyzed for antimicrobial compound(s) using the disk bioassay and for organic acids using high-performance liquid chromatography (HPLC). All experiments were performed in duplicate. Under these fermentation conditions, the lactose conversion rate was 25%, and maximum organic acid produced was 2.3%. Maximum organic acids and antimicrobial compound(s) were achieved after a 24h incubation period. Results of this work showed that immobilization could offer the possibility of a more stable means of producing antimicrobial compound(s) and organic acids using laboratory media, as well as whey-based medium.

Key Words: bifidobacteria, immobilization, antimicrobial compound

ASAS Nonruminant Nutrition: Enzymes, Feed Additives, and Environment Management in Finishing Pigs

748 Effect of xylanase inclusion level on nutrient digestibility of diets containing different corn varieties and wheat middlings in finishing pigs. Young Hyun*¹, Mike Ellis¹, and Howard Simmins², ¹University of Illinois, Urbana, ²Finnfeeds International Ltd., UK.

The objective of this study was to determine the effect of dietary xylanase supplementation (Porzyme #, Finnfeeds International Ltd., UK) on nutrient digestibility in diets based on either waxy or normal corn and containing 20% wheat middlings, in finishing pigs. The study was conducted using a 4 x 4 Latin Square design having 2 x 2 factorial arrangement of treatments. The treatments were 1) type of corn (waxy vs normal) and 2) enzyme level (0.000 vs 0.125 %). Eight pigs fitted with a post-valve T-cecal cannula were used to measure the apparent ileal digestibility of nutrients. The average initial BW was 101.0 ± 7.25 kg and the average final BW was 118.8 ± 6.22 kg at the end of a four-week study period. The normal corn and waxy corn diets were formulated to the same content (3,241 vs 3,246 ME Kcal/kg; 18.3 vs 18.2 % CP and 0.66 vs. 0.66 % true ileal digestible lysine, respectively). Chromic oxide (0.5 % of the diet) was used as a marker for the determination of the ileal digestibilities. For the first period (week) of the study, pigs were fed 2.4 kg of feed per day in two equal meals at 8 am and 3 pm (1.2 kg per meal). Feed intake was increased by 200 g per day (100 g per meal) after each experimental period. Pigs had free access to water. In each period, the pigs were allowed to adapt to the diets for five days (days 1 to 5). Ileal digesta were collected on days 6 and 7, in two 12-hr periods from 0700 h to 1900 h. There were no interactions (P > 0.05) between corn type and enzyme level for nutrient digestibility. The waxy corn had higher (P < 0.05) ileal digestibility for dry matter and energy than the normal corn (65.5 vs 61.7 SE 0.99 % and 66.4 vs 62.6 SE 1.10 %, respectively). However, there was no difference (P < 0.05) in crude protein digestibility between the corn types. Dietary supplementation with the enzyme at 0.125 % of the diet when compared to the control treatment resulted in higher digestibility for dry matter (60.5 vs 66.7 SE 0.99 %, P < 0.01), protein (70.6 vs 74.0 SE 0.93 %, P < 0.05) and energy (61.5 vs 67.5 SE 1.10 %, P < 0.01). Xylanase supplementation improved ileal digestibility of nutrients in diets based on both normal and waxy corn and wheat middlings.

Key Words: Xylanase, Ileal digestibility, Finishing pigs

749 Effects of feed processing technologies and diet formulation strategies on growth performance and carcass characteristics in finishing pigs. D. J. Lee, J. D. Hancock, G. A. Kennedy*, C. L. Jones, and C. W. Starkey, Kansas State University, Manhattan.

A total of 176 crossbred pigs (avg initial BW of 52 kg) were used to determine the effects of feed processing technologies and diet formulation strategies on growth performance and carcass characteristics in finishing pigs. The pigs were blocked by sex and weight and allotted to 16 pens with 11 pigs per pen. Corn (mean particle size of 900 microns)-soybean meal-based diets, formulated to 17% CP, 0.60% Ca, and 0.50% P for d 0 to 39 and 14% CP, 0.54% Ca, and 0.45% P for d 39 to 67, were used as the control. Low-excretion diets were formulated to 15% CP (with added lys, thr, met, and trp), 0.61% Ca, and 0.51% P for d 0 to 39 and 12% CP (with added lys, thr, met, and trp), 0.48% Ca, and 0.40% P for d 39 to 67. Also, these diets had 5% soybean oil, and for d 39 to 67, the vitamin and trace mineral premixes were omitted. To enhance nutrient digestion in these diets, the corn was ground to a mean particle size of 600 microns and the diets were steam conditioned (82°C), expander processed (cone pressure of 14.1 kg/cm²), and pelleted (diameter of 4.8 mm). Finally, phytase (500 FTU/kg) was sprayed onto the cooled pellets. The pigs were slaughtered at a commercial plant and the pars esophagea of the stomachs were collected and scored on a scale of 0 to 3 (0 = none, 1 = slight, 2 = moderate, and 3 = severe) for stomach ulceration. Rate and efficiency of gain were increased by 11 and 13% (P < 0.001) for pigs fed the low-excretion diets. Dressing percentage and FFLI were not affected (P > 0.10), but last rib backfat thickness was increased (P < 0.04) and ulcer scores were greatest (P < 0.001) for pigs fed the low-excretion diets. Our data suggest that growth performance was increased with low-excretion diets, but pigs fed these diets tended to be fatter and have greater scores for stomach ulcers.

Item	Control	Low excretion	SE
ADG, kg	0.82	0.92	0.01
Gain/feed	0.291	0.335	0.005
Dressing %	73.4	73.8	0.3
Backfat, mm	25	27	0.4
FFLI, %	51.6	51.1	0.2
Ulcer score	0.00	2.08	0.09

Key Words: Pig, Growth, Nutrient excretion

750 Improving ileal and total tract digestion of corn and soybean meal-based diets by growing pigs using feed enzymes, steeping, and particle size reduction. M. R. Smiricky*, K. L. Saddoris, D. M. Albin, V. M. Gabert, and G. C. Fahey, Jr., University of Illinois, Urbana.

Limited research has been reported concerning the efficacy of fiber-degrading enzymes (FDE) in conjunction with feed steeping and /or phytase supplementation. These enzymes may assist in the digestion of the incompletely utilized fibrous fraction of corn and soybean meal. Twelve barrows were surgically fitted with a simple T-cannula at the distal ileum to evaluate the efficacy of the addition of the FDE, α -galactosidase (0.3%), cellulase (0.1%), hemicellulase (0.2%), pectinase/arabinase (0.1%), and xylanase (0.05%) with or without feed steeping, and with or without 0.5% phytase on large (731 micron) and small (555 micron) particle size diets. The barrows were separated into two 6 x 6 Latin squares. Square 1 utilized 731-micron particle size diets and square 2 utilized 555-micron particle size diets to test the efficacy of enzymes and steeping. The corn-soybean meal-based diets were formulated to contain 17% CP and chromic oxide for determination of nutrient digestibilities. Water for feed steeping was added in a 1.45:1 ratio on a weight basis. The pigs were fed 1.40, 1.52, 1.68, 1.84, 2.00, and 2.12 kg/d, respectively, for periods 1-6 in 2 equal feedings at 0800 and 2000 h. The experimental period lasted 7 d, with 5 d diet adaptation, fecal collection on d 6, and ileal digesta collection on d 7. Diets, feces, and digesta samples were analyzed for DM, OM, N, AA, and chromic oxide concentrations. Diets were analyzed for particle size. Lower particle size improved (P < 0.05) ileal digestibilities of OM, Asp, Pro, Ala, Leu, Tyr, and Phe. Lower particle size improved (P < 0.05) total tract digestibilities of N and all AA measured. Ileal and total tract digestibilities of DM, N, and AA were improved (P < 0.05) by FDE and phytase addition in combination or by feed steeping. In conclusion, decreasing particle size, the addition of phytase, as well as feed steeping improved digestibilities of most of the nutrients measured.

Key Words: Pigs, Digestibility, Enzymes

751 Use of toe ash regression analysis to compare bioefficacy of phytase enzymes. M Coelho*, B Cousins, and W McKnight, BASF Corporation.

Two hundred fifty two day old broilers were utilized in a 3X3 factorial design (10 replications/treatment) to determine the bioefficacy of Natuphos[®] compared with peniophora lysii phytase using a monocalcium phosphate standard. A phosphorus deficient corn/soybean diet was used as the control. This phosphorus deficient diet was supplemented with monocalcium phosphate (0.2, 0.4 and 0.6 g P/kg) or phytase (100, 200 and 300 U/kg). Bioefficacy was compared based on toe ash regression analysis. Regression equations of phytase on toe ash were $y = 0.0122x + 19.7$, $R^2 = 0.9715$ and $y = 0.0066x + 19.7$, $R^2 = 0.4022$ for Natuphos and peniophora lysii phytase, respectively. Toe ash increased by 0.0122 and 0.0066 mg per phytase unit for Natuphos and peniophora lysii phytase, respectively. Natuphos phytase required fewer (p.05) phytase units than peniophora lysii to reach 26.88 mg toe ash (588 and 1087 U, respectively). The bioefficacy of Natuphos phytase and peniophora lysii based on toe ash regression analysis were 100% and 54%, respectively.

Key Words: Enzymes, Phytase, Bioefficacy

752 In vitro and in vivo hydrolysis of phytate in feed ingredients and complete feeds by phytase. J. S. Sands*¹, P. H. Simmins², and O. Adeola¹, ¹Purdue University, West Lafayette, IN USA, ²Finnfeeds International Ltd., Marlborough, UK.

The hydrolysis of phytate in a variety of feed ingredients and complete feed (CF) by phytase was investigated both *in vitro* and *in vivo*. For the *in vitro* release of P in feed ingredients and CF (73% corn, 23% soybean meal; 17% CP; 0.33% P - not supplemented with inorganic P), 6 replicates of each feed ingredient or CF were used with phytase stock solution added to give: 0, 125, 250, 500, 750, 1000, 2000, or 4000 units/kg sample. The response in P release to phytase concentration was curvilinear. Under conditions used in this study, maximal P release were 0.9, 1.8, and 1.12 mg P/g sample for corn, soybean meal and CF, respectively. For wheat, barley, canola, and sunflower meals, maximal P release were 2.97, 2.97, 3.27, and 3.17 mg P/g sample, respectively. For the *in vivo* study, 36 barrows with an average initial weight of 19 kg were assigned to six diets and housed in stainless-steel metabolism crates. The CF was supplemented with 0, 250, 500, 750, or 1000 phytase units/kg diet. Pigs were fed in two equal feedings daily in a study consisting of a 5-d adjustment period followed by a 5-d period of total but separate collection of feces and urine. Fecal phosphorus output was higher ($P < 0.05$) in pigs fed CF than in those fed the phytase-supplemented diets. This led to both lower ($P < 0.05$) daily absorbed P and percent P digestibility in CF than the phytase-supplemented diets. Phytase supplementation of corn-soybean meal diet significantly improved the digestibility of phytate. Nonlinear broken-line regression analysis revealed that the optimum level of phytase in the corn-soybean meal diet used in the current experiment was 298 units/kg for daily absorbed P and 326 units/kg for percent P digestibility. The digestibilities of nitrogen and energy were not affected by phytase supplementation. The results of these studies show that the phytase preparation is efficacious in hydrolyzing phytate.

Key Words: Pigs, Phytase, Phosphorus

753 Enhanced phosphorus digestion and reduced pollution potential by transgenic pigs with salivary phytase. Serguei Golovan, Roy Meidinger, Ayodele Ajakaiye, Michael Cottrill, Claire Plante, Ming Fan, Anthony Hayes, Roger Hacker, John Phillips, and Cecil Forsberg*, University of Guelph, Guelph, Ontario, Canada.

To address the problem of manure-based environmental phosphorus pollution in the pork industry, we have developed phytase transgenic pigs. The transgene introduced into pigs by pronuclear microinjection is composed of the mouse parotid secretory protein promoter and the *Escherichia coli appA* phytase gene. The transgenic pigs secrete the enzyme phytase in their saliva that hydrolyzes dietary phytate releasing phosphorus which is readily absorbed in the small intestine. Without this enzyme, phytate phosphorus passes undigested into the manure. These pigs offer a unique biological approach to management of phosphorus nutrition and environmental pollution in the pork industry.

Key Words: Transgenic pigs, Phytase, Phosphorus digestibility

754 The effects of phytase on calcium, phosphorus, and dry matter digestibility in pigs fitted with steered ileocecal valve cannulas. J.P. Rice*, J.S. Radcliffe, and R.S. Pleasant, Virginia Polytechnic Institute and State University.

Twelve crossbred barrows fitted with steered ileo-cecal valve cannulas were used in a replicated 6 x 6 Latin square design to investigate the effects of phytase on Ca, P and DM digestibilities. Each 2-wk period consisted of a 7-d adjustment, a 3-d total collection, a 12-h ileal digesta collection, a 3-d adjustment to the enzymatically hydrolyzed casein (EHC) diet and a second 12-h ileal digesta collection. The EHC diet was fed to supply readily available amino acids so that true amino acid digestibilities could be determined. All diets, except for the EHC diet, were corn-soybean meal based and contained 0.15% available P, 0.44% Ca, and 0.05% Cr₂O₃ as an indigestible marker. Water was supplied ad libitum and feed was supplied at a level of 9% of metabolic BW (BW^{0.75})/d. Pigs were weighed prior to the start of each period and feeding levels were adjusted. Diets 1, 2 and 3 contained 13.0, 12.0 and 11.0% CP, respectively. Diets 4, 5 and 6 were Diet 3 plus 250, 500 or 750 U of phytase per kilogram of diet, respectively. Digesta and fecal samples were pooled by pig for each collection day/period and analyzed for P, Ca, Cr and DM. As the level of dietary CP decreased, ADG ($P < 0.001$)

and feed efficiency ($P < 0.01$) decreased linearly. The addition of phytase to the low CP diet did not affect ($P < 0.10$) ADG or feed efficiency. The addition of phytase to the diet resulted in a linear increase ($P < 0.001$) in P apparent ileal digestibility (AID) and Ca apparent total tract digestibility (ATTD), a quadratic increase ($P < 0.01$) in P ATTD, and a tendency ($P < 0.10$) towards an increased Ca AID and DM ATTD. As the level of dietary CP was decreased a quadratic response ($P < 0.05$) was observed for P and DM AID and ATTD. Calcium AID and ATTD were unaffected by dietary CP level. Pigs fed the 12.0% CP diet had a higher P and DM AID and ATTD compared to pigs fed the 13.0 and 11.0% CP diets. Phytase addition to the diet improved P and Ca AID and ATTD and tended to improve DM ATTD.

Key Words: Pig, Phytase, Digestibility

755 Xylanase improves the ileal energy and nitrogen digestibility of high wheat finisher diets containing increasing levels of wheat shorts in swine. S. C. Wolford¹, P. H. Simmins², and T.A.T.G. van Kempen*¹, ¹North Carolina State University, ²Finnfeeds International.

Wheat and wheat byproducts contain non-starch polysaccharides, predominantly arabinoxylans, which negatively affect nutrient digestibility. In-feed xylanases reduce the anti-nutritional effects of the arabinoxylans on digestibility, although responses have been variable in pigs. The efficacy of three levels of xylanase (0, 4000, and 7000 IU/kg, Porzyme[®] 9300) in diets containing 77% wheat + 10% wheat shorts, 67% wheat + 20% wheat shorts, and 57% wheat + 30% wheat shorts was evaluated in an ileal digestibility experiment. Diets were evaluated in nine ileally cannulated grower pigs using a Youden square design with eight periods. Ileal digesta were collected over a 2-d period following a 5-d adaptation period. The model that best described the results used wheat shorts level as a discrete variable and enzyme level as a continuous variable. No significant interactions occurred between wheat shorts level and enzyme level. Increasing wheat shorts from 10 to 20% numerically reduced energy digestibility with $0.99 \pm 0.65\%$ ($P = 0.13$) without affecting nitrogen digestibility ($P = 0.48$), and when increased from 20 to 30%, energy digestibility was reduced with $3.23 \pm 0.65\%$ and nitrogen digestibility was decreased $1.29\% \pm 0.55$ ($P < 0.05$). Xylanase linearly increased nitrogen and energy digestibility of the diets within the range tested, with an increase in digestibility for energy of $0.37 \pm 0.09\%$ and for nitrogen of $0.22 \pm 0.08\%$ for each IU enzyme per g of feed ($P < 0.05$). Interestingly, xylanase decreased both the indigestible nitrogen and energy with approximately 1.2% for each IU enzyme per g of feed. Results from this experiment indicate that increasing wheat shorts inclusion from 20 to 30% has a negative effect on digestibility of energy and nitrogen. Xylanase improved the digestibility of both nitrogen and energy in a linear fashion. In conclusion, the in-feed xylanase improves the digestibility of both nitrogen and energy in high wheat swine diets containing between 10 to 30% inclusion of wheat shorts.

Key Words: Swine, Digestibility, Xylanase

756 Use of feed processing technologies and diet formulation strategies to maximize digestibility and minimize excretion of nutrients in finishing pigs. D. J. Lee*, J. D. Hancock, J. M. DeRouchey, C. A. Maloney, and D. W. Dean, Kansas State University, Manhattan.

Six crossbred barrows (70 kg average BW) were used in a repeated 2 x 2 Latin square design to determine the effects of feed processing technologies and diet formulation strategies on nutrient utilization. A corn (ground to a mean particle size of 900 microns)-soybean meal-based diet, formulated to 16.5% CP, 0.55% Ca, and 0.50% P, was used as the control. A low-excretion diet was formulated to 13.4% CP (with added lys, thr, met, and trp), 0.45% Ca, and 0.40% P. Also, this diet had 5% soybean oil and the vitamin and trace mineral premixes were omitted. To enhance nutrient digestion in this diet, the corn was ground to a mean particle size of 600 microns and the diet was steam conditioned (82°C), expander processed (cone pressure of 14.1 kg/cm²), and pelleted (diameter of 4.8 mm). Finally, phytase (500 FTU/kg) was sprayed onto the cooled pellets. In this 14-d experiment, initial and final BW were not different for pigs fed the control vs the low-excretion diet ($P > 0.27$). Dry matter intake was similar for pigs fed the two diets ($P > 0.07$) but DM excretion was decreased by 35% for pigs fed the low-excretion diet ($P < 0.001$). Nitrogen intake and excretion were decreased ($P < 0.003$) by 22 and 39% and P intake and excretion by 27 and 51% ($P < 0.002$)

for pigs fed the low-excretion diet. Apparent ileal digestibilities of lysine and threonine were increased by 11 and 18% ($P < 0.02$) and DE and ME were increased by 11 and 12% ($P < 0.004$) for pigs fed the low-excretion vs the control diet. Our data indicate markedly desirable effects on digestibility and excretion of nutrients from currently available processing technologies and diet formulation strategies.

Item	Control	Low excretion	SE
DM intake, g/d	2,064	2,128	18
DM excreted, g/d	477	311	5
N intake, g/d	73.1	56.9	0.6
N excreted, g/d	43.1	26.2	1.8
P intake, g/d	12.4	9.1	0.1
P excreted, g/d	10.5	5.1	0.3
Ileal lys dig, %	79.0	88.3	1.7
Ileal thr dig, %	64.4	78.5	2.2
DE of the diet, kcal/kg	3,657	4,117	17
ME of the diet, kcal/kg	3,181	3,617	51

Key Words: Pig, Digestibility, Nutrient excretion

757 Dietary factors are additive in reducing in vitro ammonia emission from pig manure. G.C.M. Bakker*¹ and M.C.J. Smits², ¹*ID TNO Animal Nutrition, Lelystad*, ²*IMAG, Wageningen*.

In the past the effects of dietary factors on ammonia emission from pig manure have been studied separately and not in combination. Therefore, in the present study it was hypothesized that the effects of the tested dietary factors on ammonia emission are additive. Of each of the four dietary factors three levels were studied: crude protein (142, 161 and 180 g/kg), calcium sulfate (0, 9 and 18 g/kg), dietary fiber (129, 189 and 245 g/kg) and fermentable fiber (62, 83 and 104 g/kg). The number of $3^4=81$ potential dietary combinations was reduced to 26 by using a fractional design for the study, the Box-Benken design. This design allowed quantifying linear and quadratic main effects and two-way interactions, whereas from the more complex interactions only qualitative information could be obtained. The 26 diets contained similar amounts of ileal digestible amino acids, minerals and net energy. In total 39 individually housed pigs were used; two diets were tested more than once for determining standard deviation. All pigs were allowed a 3-week adaptation period and received similar amounts of water and energy. Their mean weight during the test period was 70 kg. In a 5-day period feces and urine were collected and mixed as slurry. A sample from this slurry was placed in an in vitro system to determine the cumulative ammonia emission for 7 days. Results on ammonia emission showed only linear main effects of the dietary factors; there was no evidence for quadratic or interaction effects. Of the four feed components, only dietary fiber had no effect on ammonia emission. The equation was: cumulative ammonia emission (g per 7 d) = $-5.67^{***}(0.678) + 0.058^{***}(0.0035) \times \text{protein content} - 0.052^{***}(0.0073) \times \text{calcium sulfate} - 0.011^{**}(0.0037) \times \text{fermentable fiber}$; R-square = 93.2; all feed factors in g/kg. We concluded that the effects of the dietary factors on ammonia emission are additive. However, these in vitro results need to be validated under pig house conditions, where excretion patterns, floor pollution and climate, especially air flow dynamics are included.

Key Words: Ammonia emission, Dietary factors, Pig manure

758 Effect of dietary crude protein level and fiber sources on nitrogen excretion patterns of grower pigs. S. Zervas^{1,2} and R.T. Zijlstra*¹, ¹*Prairie Swine Centre Inc.*, ²*University of Saskatchewan, Saskatoon, Canada*.

Successful nitrogen (N) management is important for sustainable pork production. Effects of dietary CP (high, 18.5%; low, 15.6%) and fiber sources (control, soybean hulls (SH; 15%), and sugar beet pulp (SBP; 20%) on N-excretion patterns were studied in a 2x3 factorial arrangement. Diets were formulated to 3.3 Mcal DE/kg and 2.4 g dLys/Mcal, supplemented with Lys, Met, Trp, Thr, Ile, and Val to maintain a similar content of digestible AA. Pigs (30.5 \pm 3 kg; n = 30) were housed in confinement-type metabolism crates, with restricted access to feed (3 x maintenance DE) from d 1 to 18, and free access to feed from d 19 to 26. Feces and urine were collected from d 15 to 18 and d 23 to 26, and blood on d 25. With restricted access to feed, feces N (as % of N intake) was increased 3% for low vs high CP, and increased 5% for SH and 7%

for SBP compared to control ($P < 0.05$); urine N was reduced 5% for low vs high CP, and reduced 4% for SH and 8% for SBP compared to control ($P < 0.05$). Retention of N (in g/d) was reduced 12% for low vs high CP (17 vs 19 g/d; $P < 0.05$), and similar among fiber treatments ($P > 0.10$). With free access to feed, feces N (as % of N intake) was increased 3% for low vs high CP, and increased 6% for SH and 9% for SBP compared to control ($P < 0.05$); urine N was reduced 6% for low vs high CP, and reduced 8% for SH and 10% for SBP compared to control ($P < 0.05$). Retention of N (in g/d) was similar for CP levels (29 g/d; $P > 0.10$), and reduced for SH (27 g/d; $P < 0.05$) compared to control (31 g/d), and intermediate for SBP (29 g/d). Plasma urea was correlated to urine N ($R^2 = 0.69$; $P < 0.001$). Reduction of dietary CP reduced urine N, and fiber sources high in fermentable fiber shifted N excretion from urine N to feces N. Level of feed intake is an important consideration when effectiveness of a nutrient management strategy is studied. Diets with a low CP and containing synthetic AA should be studied using pigs with free access to feed to verify that nitrogen retention is maintained.

Key Words: Pig, Nitrogen excretion, Fiber

759 Efficacy of betaine as a carcass modifier in finishing pigs fed normal and low protein diets supplemented with amino acids. L. A. Pettey*, G. L. Cromwell, M. D. Lindemann, J. H. Randolph, H. J. Monegue, K. M. Laurent, G. R. Parker, and R. D. Coffey, *University of Kentucky, Lexington*.

Three experiments were conducted to determine if betaine would overcome the reduced carcass leanness often associated with feeding low protein, AA supplemented diets to pigs. Exp. 1 and 2 involved 192 pigs (10 reps of five pigs/pen) from 53 to 113 kg BW. Diets 1 and 3 were fortified corn-soy with adequate CP (16% to 85 kg, then 14.5%) or low CP (12%, 10.5%) with added lys (0.30%), thr (0.08%), and trp (0.03%). Diets 2 and 4 were the same as 1 and 3 except betaine was included at 1.14 g/kg (0.125% Betafin[®] [Finnfeeds Intl., Ltd, Marlborough, U.K.]). Lys levels in all diets during the two phases were 0.80 and 0.70%. All pigs were scanned by real-time ultrasound at 110 kg. ADG, feed/gain (F/G), 10th rib backfat (BF), and estimated carcass lean for pigs fed diets 1-4 were: 916, 918, 857, 882 g; 3.48, 3.53, 3.66, 3.50; 23.2, 22.1, 23.7, 23.4 mm; 52.9, 53.6, 52.6, 52.9%. Low CP resulted in slower gains, more BF, and reduced carcass lean ($P < 0.05$). Betaine improved F/G in pigs fed low CP ($P < 0.05$) and improved leanness in pigs fed adequate CP ($P < 0.05$). In Exp. 3, 180 pigs (six reps of five pigs/pen; 37 to 117 kg) were fed diets with (1) adequate CP during three phases (17.5/15.5/13.5%), (3) reduced CP (16/14/12%) with added lysine (0.15%), or (5) low CP (14.5/12.5/10.5%) with lys (0.30%), thr (0.08%), and trp (0.03%). CP levels were changed at 56 and 84 kg BW. Three other diets (2, 4, and 6) were as 1, 3, and 5 but with betaine. Lys levels during the three phases were 0.90, 0.80, and 0.70%. All pigs were scanned at 114 kg. ADG, F/G, BF, and carcass lean for pigs fed diets 1-6 were: 943, 955, 948, 934, 950, 930 g; 2.86, 2.94, 2.93, 2.96, 2.87; 20.9, 21.2, 21.1, 21.5, 22.4, 21.6 mm; 53.9, 53.6, 53.9, 53.4, 53.0, 53.7%. Performance was unaffected by diet. Carcasses tended to be fatter with less lean in pigs fed low CP, and this appeared (ns, $P=0.10$) to be alleviated with betaine. In this study, the effects of betaine on performance and carcass leanness in pigs were inconsistent.

Key Words: Pigs, Betaine, Amino acids

760 Descriptive flavor analysis of bacon and pork loin from lean-genotype gilts fed conjugated linoleic acid. L. Averette Gatlin*, D.K. Larick, M.T. See, and J. Odle, *North Carolina State University Raleigh*.

Conjugated linoleic acid (CLA) supplementation has previously been demonstrated to increase firmness of pork bellies. However, effects of CLA on flavor of pork have not been described. This study evaluated the combined effects of dietary CLA and supplemental fat (SF) on organoleptic characteristics of bacon and pork loin samples. Lean-genotype gilts (49.3 kg; n=48) were randomly assigned to a 2 x 3 factorial arrangement of supplemental fat level and linoleic acid supplementation for the final 47d of finishing. Supplemental fat treatments included 0%, 4% yellow grease (YG), and 4% tallow (T). Linoleic acid (LA) treatments included 1% corn oil (CO) or 1% CLA (CLA-60, Natural Lipids, Norway). Lysine:calorie ratio was constant in all diets. A trained six-member sensory panel developed a flavor profile on commercially cured bacon samples (12 descriptors) and center-cut boneless pork loin chops (19 descriptors) using a 14-point universal intensity scale. Samples were

vacuum packaged and stored at -7 C, then thawed in a refrigerator 20 to 24 h and cooked immediately prior to analysis. Bacon samples from pigs fed 4% SF were considered to have a sweeter flavor (4.07 .07) than those fed 0% SF (3.89 .07; $P < .04$). The intensity of salty flavor was higher in bacon samples from pigs fed CO (6.18 .09) compared to those fed CLA (5.86 .10; $P < .02$). The intensity of salty aftertaste was greater when CO was combined with YG (5.21 .14; $P < .07$) or T (5.44 .14; $P < .01$) than CO alone (4.85 .14) but SF combined with CLA was not different from CLA alone (SF * LA; $P < .02$). Sour flavor intensity tended to be lower in loin samples from pigs fed CLA than from those fed CO (1.60 vs 1.73 .06; $P < .09$). Samples from animals fed 4% T tended to have slightly lower ($P < .09$) notes of astringent aftertaste (1.42 .08) compared to those fed 0% SF (1.62 .09) or 4% YG (1.66 .09). In summary, minimal differences in flavor descriptors determined by the sensory panel were detected. Panel results indicate consumer acceptance of bacon and pork products from pigs fed CLA will not differ from commodity pork products.

Key Words: Conjugated Linoleic Acid, Pork flavor, Bacon

761 Effect of dietary betaine supplementation on energy partitioning in pigs. J.W. Schrama¹, P.H. Simmins², and W.J.J. Gerrits^{*1}, ¹Wageningen Institute of Animal Science, Wageningen University, Wageningen, The Netherlands, ²Finnfeeds International Ltd, Malborough, UK.

The effect of dietary betaine supplementation on energy partitioning in pigs was studied. Six groups of 14 group-housed barrows were assigned

to one of two dietary treatments: control or betaine supplemented (1.25 g Betafin[®] per kg of feed). The experimental diets were maize and soybean meal-based. Diets were aimed to be limiting in energy content and sufficient in protein. The experiment consisted of a 3-wk adaptation and a 3-wk experimental period. Initial BW was 46 kg during the experimental period, when each group of pigs was housed in a climate respiration chamber. During the experimental period, pigs were offered changed diets, which were diluted with 10% oat hulls. Pigs were fed at 2.5 times the energy requirements for maintenance. During the experimental period, heat production, energy and nitrogen balances were measured weekly. The metabolizable energy intake was unaffected by dietary betaine supplementation ($P > 0.10$). Averaged over the experimental period, betaine supplementation reduced heat production ($5 \text{ kJ} \cdot \text{kg}^{-0.75} \cdot \text{d}^{-1}$, $P < 0.05$). Moreover, this difference between diets increased with time within the experimental period ($P < 0.05$). Averaged over the 3-wk period, energy retention was increased ($P < 0.10$) and energy requirements for maintenance were decreased ($P < 0.10$) in pigs fed the betaine supplemented diet. However, the effect of betaine on the energy requirements for maintenance changed with time ($P < 0.05$). Maintenance requirements were similar in Week 1 and were reduced by betaine supplementation by 5.5% during Week 3 (477 vs. 452 $\text{kJ} \cdot \text{kg}^{-0.75} \cdot \text{d}^{-1}$). The current results showed that betaine supplementation affected energy partitioning of growing pigs. This effect was not due to a methionine sparing effect of betaine, because diets were formulated to be sufficient in amino acid as well as choline.

Key Words: Pigs, Betaine, Energy metabolism

ASAS Swine Species

762 ECG-gated dynamic MR examination of pig heart. Robert Romvari¹, Imre Repa¹, Zsolt Petras¹, Gabor Bajzik¹, Bela Fenyves², and Peter Horn^{*1}, ¹Kaposvar University, Faculty of Animal Science, Diagnostic Institute, ²Szent Istvan University, Faculty of Veterinary Science, Department and Clinic of Surgery.

The selection of pigs for high lean meat production plays an important role in the disadvantageous changes of the circulatory system. In pork production cardiovascular disorders mean serious problems during fattening, namely 14 to 18 % of the total deaths have a circulatory background.

For in vivo examination of the porcine heart, dynamic MR imaging methodology was developed. Measurements were carried out on 15 meat type pigs (22 or 106 kg) using a Siemens Magnetom Vision Plus type equipment of 1.5 T magnetic-field strength.

Regarding the motion sensitiveness, inhalation anaesthesia was applied, then ECG-gating synchronised the data acquisition with the pulsation of the heart. At first quick images were made to locate the heart according to the co-ordinate system of the body. Following in the sagittal, coronal and transversal planes localisation images were taken to allocate the longitudinal axis of the heart. Finally, depending on the heart frequency and on the size of the heart, in each case 8 to 10 slices and in each slice 8 to 14 cine images were acquired prospectively according to one heart cycle.

The means of traits measured in ml at 22 and 106 kg liveweight, respectively were; left ventricular end-diastolic volume: 51.4 vs. 125.7, left ventricular end-systolic volume: 24.4 vs. 60.1, left ventricular stroke volume: 27.0 vs. 65.6, right ventricular end-diastolic volume: 55.7 vs. 118.4, right ventricular end-systolic volume: 28.6 vs. 52.5, right ventricular stroke volume: 27.1 vs. 65.9. The left ventricular ejection fraction: 52.5 vs. 52.2 and the right ventricular ejection fraction: 48.7 vs. 55.7 were given in percentage. The cardiac output values were 3.5 l (22 kg, 132 beat/min.), and 6.0 l (106 kg, 91 beat/min.), respectively. The contraction values were also determined by the septum (70%), and by the anterior (61%), posterior (41%) and lateral (54%) walls.

Based on the investigation, the preconditioning, the narcotic procedure, the specific details of ECG measuring (i.e. proper signal transmission) and the correct MR imaging were worked out. After our results we declare this methodology as a well applicable one in the quantitative measurement of the heart, where each investigation takes 30 to 40 minutes.

Key Words: pig, heart, magnetic resonance imaging

763 A comparison of methods of editing and adjusting feed intake data from electronic swine feeders. D.S. Casey^{*} and J.C.M. Dekkers, Iowa State University, Ames, Iowa.

Data from electronic swine feeders contain errors that must be identified, edited, and replaced. The objective of this study was to compare the accuracy of six methods of editing and replacing missing data to estimate daily (DFI) and average daily feed intake (ADFI) in short and long test periods. Data from FIRETM feeders on 591 pigs from the National Pork Producers Council's Maternal Line Genetic Evaluation Program were used. Errors in each visit were identified using 16 criteria. To create an error-free data set as a basis for comparison, data from 124 pigs with few errors were selected and visits with errors were replaced by error-free visits from the same pig. Resulting DFI and ADFI were assumed to be the true trait values. Error visits were then introduced to create long test period data (average 12 weeks), representative of real data. The last 4 weeks per pig were used to create short test period data. Data were edited using 6 methods (EM1-6). For EM1, a DFI record was deleted if $\text{DFI} < 1000\text{g}$ or $> 4500\text{g}$. For EM2-6, the 16 criteria were used to identify errors in each visit. For EM2 and 3, all DFI records with ≥ 1 and ≥ 2 error visits were deleted. For EM4-6, DFI was obtained by summing feed intake over error-free visits. For EM5 and 6, DFI records were then adjusted for the effects of presence of error visits on unadjusted DFI, which were estimated from a linear model analysis of the complete data set (591 pigs) for EM5 or from the data sets being edited (124 pigs) for EM6. For EM1-4, missing DFI records were replaced by linear or quadratic regression estimates of DFI on test day for each pig. DFI and ADFI from the edited data sets were correlated to true values. Correlations were high (.89 to .99) for both traits for all editing methods except EM1. EM6 had the highest correlations for DFI in both test periods ($\geq .96$). EM2 and EM6 had the highest correlations for ADFI (.98 to .99). EM1 had the lowest correlations for both traits and test periods (.76 to .94). Results indicate that editing methods affect the accuracy of data from electronic feeders. EM6 is recommended for maximum accuracy.

Key Words: Swine, Feed Intake, Editing Methods

764 Effects of piglet birth weight and liquid milk replacer feeding during lactation on pig performance to slaughter weight. B. F. Wolter^{*}, M. Ellis, B. P. Corrigan, and J. M. DeDecker, University of Illinois, Urbana, IL.

The effects of piglet birth weight and liquid milk replacer feeding during lactation on growth performance to slaughter was evaluated in a study

carried out with thirty-two sows (PIC C-22) and their piglets (n=384, PIC Line 337 sires). A randomized block design with a 2 × 2 factorial arrangement of treatments was used. Treatments were birth weight (Heavy and Light) and liquid milk replacer (Supplemented or Unsupplemented). The study was divided into 2 periods. In period 1 (birth to weaning), pigs were assigned at birth to either a heavy or light (1.83 vs 1.32, SE = 0.01 kg; P < 0.001) litter of 12 pigs and one-half the litters were given ad libitum access to supplemental milk replacer (Land O'Lakes, Inc., Fort Dodge, IA) from d 3 of lactation to weaning. In period 2 (from weaning at 21 d of age to slaughter at 110 kg), a total of 308 randomly selected pigs were allocated at weaning within previous treatment group and sex to pens of 4 pigs. Pigs were given ad libitum access to feed, and diets were formulated to meet or exceeded NRC recommendations. Heavy litters were heavier at weaning (6.58 vs. 5.72, SE = 0.14 kg; P < 0.001), tended to have more pigs weaned (11.4 vs. 10.9, SE = 0.21 pigs; P = 0.10), had greater post-weaning ADG (850 vs. 800, SE = 6.7 g; P < 0.001) and ADFI (1866 vs. 1783, SE = 17.6 g; P < 0.001), similar G:F (0.46 vs. 0.45, SE = 0.003; P > 0.10), and required 7 fewer d (P < 0.001) to reach slaughter. Feeding supplemental milk replacer during lactation produced heavier pigs at weaning (6.60 vs. 5.69, SE = 0.14 kg; P < 0.001), tended to increase pigs weaned (11.4 vs. 10.9, SE = 0.21 pigs; P = 0.10), but had no effect (P > 0.10) on growth performance from weaning to slaughter; however, milk replacer fed pigs required 3 fewer d (P < 0.01) to reach slaughter weight. Sow feed intake and BW loss during lactation was not affected (P > 0.10) by either birth weight or milk replacer treatment. In conclusion, pigs with heavier weaning weights resulting from increased birth weight or from feeding of milk replacer required less time to reach market weight.

Key Words: Pigs, Weaning Weight, Milk Replacer

765 Effect of initial stocking rate and weighing frequency on pig performance in wean-to-finish pens. B.F. Wolter*¹, M. Ellis¹, S.E. Curtis¹, G.R. Hollis¹, R.D. Shanks¹, E.N. Parr², and D.M. Webel², ¹University of Illinois, Urbana, IL/USA, ²United Feeds, Inc., Sheridan, IN/USA.

Crossbred pigs (n = 1,560) were used in a randomized-block design with a 2 × 2 factorial arrangement of treatments to determine the effects of initial stocking rate (Single [52 pigs/pen] vs. Double [104 pigs/pen]) and weighing frequency (High [every 2 wk during the study] vs. Low [3 times during the study]) on pig performance from weaning (5.8 ± 0.43 kg BW; 17 d of age) to slaughter (114 kg BW). Floor and feeder space allowances per pig were 0.650 m² and 4 cm and 0.325 m² and 2 cm for Single- and Double-stocked pens, respectively. Drinker allocation (13 pigs/drinker) was the same for all treatments. At the end of wk 10 post-weaning, Double-stocked pens were divided into 2 equal-sized groups with similar mean BW and CV of BW, and pigs in one of the groups were moved to a different location in the same house. Pigs had free access to feed and water throughout. In the first 10 wk post-weaning, Double compared to Single stocking resulted in lighter pigs (39.7 vs. 42.6 kg; P < 0.001) and lower ADG (8%; P < 0.001) and ADFI (7%; P < 0.001), but similar G:F (P > 0.10). From wk 10 to slaughter, pigs that previously had been on the Double- compared to the Single-stocking-rate treatment had similar ADG and ADFI (P > 0.10), but greater G:F (4%, P < 0.01). Double-stocked pigs required 2 additional days to reach slaughter BW (P < 0.05), but had similar (P > 0.10) carcass backfat and loin depths. Double-stocked pigs moved at the end of 10 wk had similar (P > 0.10) growth performance to those that stayed in the original pen. Growth rate was not affected (P > 0.10) by frequency of weighing. Mortality and morbidity were similar (P > 0.10) for all treatments. In summary, Double stocking reduced growth rate to 10 wk post-weaning and increased days to reach slaughter BW, but increased subsequent feed efficiency.

Key Words: Pigs, Stocking Rate, Wean-to-Finish

766 Effect of feeder-trough space on pig growth performance in double-stocked wean-to-finish pens. B.F. Wolter*¹, M. Ellis¹, S.E. Curtis¹, E.N. Parr², and D.M. Webel², ¹University of Illinois, Urbana, IL/USA, ²United Feeds, Inc., Sheridan, IN/USA.

Previous research has shown that double-stocking compared to single-stocking pigs in wean-to-finish pens reduced growth performance from weaning to 10 wk post-weaning. The objective of the current experiment was to evaluate the effect of doubling feeder-trough space (4 cm/pig

[Double] vs. 2 cm/pig [Control/Standard]) on pig performance from weaning to 8 wk after weaning. In a randomized-block design, crossbred pigs (n = 1,728) were randomly allocated at weaning (5.4 ± 0.23 kg BW; 16 d of age) to mixed-sex pens of 108 pigs/pen on the basis of weight and sex. Floor-space allowance (0.30 m²/pig) and drinker allocation (14 pigs/drinker) were the same for both treatments. Two six-place (35 cm/place) feeders (Jumbo Wean-to-Finish, Farmweld, Teutopolis, IL) positioned together in the center of each pen were accessible from both sides. However, only one feeder contained feed in pens on the Control trough-space treatment. Pigs had free access to feed and water. Pigs were weighed and feed disappearance was recorded every 2 wk throughout. Doubling feeder-trough space did not affect (P > 0.10) pig growth rate from weaning to the end of wk 6 after weaning. Pigs on the Double compared to those on the Control trough-space treatment had higher ADG (669 vs. 633 g; P < 0.05) from wk 6 to 8 and were heavier (31.7 vs 30.9 kg; P < 0.05) at the end of wk 8, although, ADFI and G:F did not differ (P > 0.10). These results suggest that pigs double-stocked in wean-to-finish pens for longer than 6 wk post-weaning need additional feeder-trough space to maintain growth performance.

Key Words: Pigs, Feeder Space, Wean-to-Finish

767 Carcass and meat quality of halothane gene carriers and negative pigs. Jorge Galindo-Garcia*, Daniel A. Villagomez, and David R. Sanchez-Chipres, *Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara, Mexico.*

Among the major genes identified in swine, the halothane gene, perhaps, is the most economically relevant due to its detrimental effects on technological meat quality parameters (Enfalt, 1997). Because differences in gene penetrance are expected when the same genotypes are exposed to different environments, (Falconer, 1989) we carried out this investigation to evaluate the halothane gene effects on carcass quality and technological traits of pork from commercial hybrids pigs (F₁ York/Landrace X synthetic hybrids), which were carriers (Nn) or negative (NN) for the Hal mutation. A total of forty three (22 females and 21 castrates) pigs, fattened in conventional housing and management, were slaughtered at 100 Kg of live weight. PCR and restriction enzyme analysis allowed Hal genotyping of pigs. For statistical analysis, the animals were grouped according to sex and halothane genotype in a 2X2 factorial array, the size of each group being nearly equal (11 animals). Carriers had shorter carcass length (P ≤ 0.05) than negative pigs. However, % carcass yield, as primary cuts, was higher for pigs carrying the major gene (P ≤ 0.05). There were no differences between groups for back fat, nor for rib eye area. Muscle pH at 45 min (*longissimus dorsi*) was significantly lower (P ≤ 0.05) in carriers than negative pigs, 6.02 vs. 6.32, respectively. Water-holding capacity was similar between groups. Nevertheless, the occurrence of pale, soft and exudative pork was higher (P ≤ 0.05) in pigs carrying the Hal gene.

Key Words: Carcass and meat quality, Halothane gene, Pig

768 Test performance of halothane gene homozygous and heterozygous pigs under no controlled climate. D. R. Sanchez-Chipres, D.A.F. Villagomez*, and J. Galindo-Garcia, *Centro Universitario de Ciencias Biológicas y Agropecuarias, Universidad de Guadalajara.*

Porcine Stress Syndrome (PSS) is a genetic disorder that mainly affects fast growing. Sudden death or pale, soft, and exudative (PSE) pork at slaughter may occur. At present, it is well known that PSS, PSE and Malignant Hyperthermia (MH) are associated with the same mutation of a ryanodine receptor gene (O'Brien, et. al.,1990; Fujii, et. al.,1991). The halothane gene (after challenging to halothane anesthesia; Archibald and Imlah, 1985) genotype of an animal is identifiable by PCR and restriction enzyme analysis. The present investigation was conducted to evaluate the productive performance of halothane negative (NN) and carrier (Nn) pigs reared individually at a test station without climate manipulation. Forty four pigs (22 females; 22 males) from commercial genetic lines (F₁ York/Landrace X synthetic hybrids) were evaluated. The test started when the animals weighted an average of 25 Kg and finished when they reached 100 Kg. The feed consumption, body weight, back fat and loin area (ultrasound) was measured during the time of the test. A frequency of 61.4 % (27 animals) and 38.6 % (17 animals) of the pigs were either NN or Nn, respectively. Better daily live weight gain was shown (P ≤ 0.05) by homozygous (NN) pigs than

heterozygous (Nn), 1.06 vs. 1.01 Kg, respectively. However, there were not statistical differences between groups on days to 100 Kg, back fat and loin area. Nevertheless, contrary to the current literature, a tendency of best performance for homozygous (NN) pigs was observed in our experimental conditions. There was no genotype X sex interaction, both sexes having similar performance.

Key Words: Test performance, Halothane gene, Pig

769 Performance Levels, Genetic Parameters and Genotype-Health Interactions for Production Traits in Pigs. R. Bergsma^{*1}, E.F. Knol¹, J.W.M. Merks¹, and G.J. Van Groenland², ¹IPG, Institute for Pig Genetics, Beuningen, ²TOPIGS, Vught, The Netherlands.

Replacement boars and gilts are potential carriers of infectious agents for pig production farms. Demand for healthy breeding stock is increasing. Consequently, production facilities of these animals should be of high health. However, from a genetic point of view questions should be raised whether 1) genetic trend realized under high health conditions (SPF) will be expressed in the same magnitude under conventional conditions, and 2) selection under SPF will, in the long term, decrease genetic disease resistance. SPF in the current analysis was defined as controlled free of Pseudorabies, PRRS, TGE, *Mycoplasma hyopneumoniae*, *Actinobacillus pleuropneumoniae*, *Brachispira hyodysenteriae*, *Pasteurella multocida* (DNT), *Streptococcus suis* (Type II), endoparasites and ectoparasites. On the conventional farms used, some, but not all, of the pathogens were present. Data analysis of a genetically linked structure of 2 SPF farms and 3 conventional farms for fertility traits, and 3 SPF- and 2 conventional farms for finishing traits yielded different performance levels under SPF for: Total Number Born (TNB, +0.7), Gestation Length (GL, -0.5 d), Nurse sow PreWeaning Mortality (PWM, -1.4 %), Test Growth (25-80 kg; TG, +143 g/d), and Ultrasonic Backfat (USB, +0.58 mm). Heritability tended to be higher only for TNB (0.13 vs. 0.10) under SPF. Genetic correlations between traits measured under SPF and under conventional conditions were positive and high ($r_g > 0.8$) for Stillborn, TNB, and TG and moderate ($0.5 < r_g < 0.8$) for GL, PWM, and USB. It is concluded that selection under the defined SPF conditions will not markedly reduce genetic trend on farms with a conventional health status. A genetic decrease in resistance is difficult to detect. Using health and performance data of SPF sired offspring in a conventional environment will help to control this potential risk.

Key Words: Pigs, Genotype Health Interaction, SPF

770 Sustainable Outdoor Pork Production. W. P. Tynan^{*}, J. G. Gentry, A. K. Johnson, H. A. Rachuonyo, J. F. Smith, and J. J. McGlone, Texas Tech University, Lubbock, Texas/USA.

A Sustainable Pork (SP) Research and Demonstration Farm was developed based on past research and the following conditions. The objectives of the SP Farm were to develop a precisely defined production technology. Acceptable criteria include that the farm does not use waste lagoons; uses no more land than a conventional indoor production system and should have no negative impact on the land. The farm may use no more labor than a conventional system and must be economically competitive. Neither may the farm have an offensive odor. It must be viewed as a positive member of the rural community. Plants used as groundcover must uptake the nutrients the animals add to the soil and

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772 Parenteral vitamin E for prevention of retained placenta in dairy cows. S. LeBlanc, K. Leslie^{*}, T. Duffield, K. Bateman, J. Ten Hag, and J. Wallace, University of Guelph, Guelph, Ontario, Canada.

Immune function is suppressed, and the risk of infectious and metabolic disease is increased in periparturient dairy cows. Several studies have shown improved immune function and decreased risk of RP or mastitis in transition cows supplemented with vitamin E in feed and/or parenterally. However, these benefits are not universally reproducible and may depend on baseline vitamin E and selenium status of animals, and other factors. Additionally, a fraction of animals will demonstrate hypersensitive reactions to parenterally administered vitamin E. The objective

recycle them by retaining carbon, nitrogen and other nutrients in a solid form. Finally, the farm should contribute healthy meat to the segment of consumers who wish to protect the environment, the animals and the workers. This niche market may be available in the United States now. Started "from scratch" on grassland that was in the Conservation Reserve Program for ten years, the farm shows the feasibility of successfully operating a 300-sow farrow-to-finish pig production outdoor sustainable farm. The farm has completed two years of operation. Production of piglets began in January 1999 and approximately 15,000 piglets have been weaned and finished outdoors. There were no health problems in the herd of 300 sows that received no sub-therapeutic antibiotics. Meat is sold to the public under the trademarked Sustainable Pork[®] label at the Texas Tech University Meats Laboratory. Visitors to the farm are impressed by the absence of odor due to the maintenance of ground cover and the manner in which the sows and piglets live a healthy, active life style. Consumers may consider their meat to be of better quality and taste panel results confirm the consumer perception of better taste in some trials. Soil analyses indicate that the farm's program of maintaining groundcover, which is being fertilized by the animals, has prevented a buildup of some nutrients in the soil. This production system works well in a dry, warm climate.

Key Words: Outdoors, Pigs, Environment

771 Evaluation of three genetic populations of pigs for response to four levels of ractopamine. A. P. Schinckel^{*1}, C. T. Herr¹, B. T. Richert¹, and M. E. Einstein¹, Purdue University.

Gilts (n = 300; BW = 83.5 kg) were allotted to pens (n = 60) by weight in a 3 x 4 factorial arrangement of treatments in a randomized complete block (n = 5) with three genotypes (G) and four ractopamine levels (RL): 1) control, 0 ppm; 2) 5 ppm; 3) 10 ppm; and 4) 20 ppm RAC to evaluate the effects of ractopamine (RAC) on growth performance in a four week trial. All pigs were fed an 18.6% CP, 1.1% lysine diet. The weekly pen data were fitted to numerous linear, nonlinear and biphasic equations of ractopamine level (RL), and either duration of time (DRAC, midweek days on RAC), or weight gain (WTGRAC, kg) on RAC. The values of DRAC and WTGRAC were set to zero for the control treatment. The RAC response was also divided into two phases: (1) RL1, 0 for control and 5 for all other RAC treatments, and (2) RL2, (RL-RL1) for RAC treatments 2, 3, and 4. For ADG (kg/d), the equations included the fixed effects of block, G and week on test ($p < .01$) and either a biphasic $[0.0186 \text{ RL} + .0272 (\text{RL}2)^{.007}]$ or nonlinear function $\{.113 [1 - \exp (-.713 \text{ RL})]\}$ of RL level. For gain:feed (G:F), the models included the fixed effects of week ($p < .01$) and either a biphasic linear $(.0084 \text{ RL}1 + .0013 \text{ RL}2)$ or nonlinear function $\{.0513 [1 - \exp (-.717 \text{ RL})]\}$. The partial sums of squares accounted for by the biphasic functions were 4.4 and 8.9% greater than the nonlinear functions for ADG and G:F, respectively. For daily feed intake (ADFI, kg/d), the equation with the lowest RSD included the fixed effects of block, G, week, and $-.0068 \text{ RL}2$ ($p < .01$). The change in the RAC response with WTGRAC were not significant ($p > .50$) for any variable. The predicted linear change in RAC response to DRAC were small for ADG $(-.0035, p = .19)$, G:F $(-.0008, p = .49)$, and ADFI $(-.0026, p = .31)$. The regression analyses indicated that the three variables respond differently to increasing RL. The biphasic and nonlinear functions of RL resulted in different predicted RAC responses. The RAC response did not significantly change over the duration of the 28-day feeding trial.

Key Words: Ractopamine, Genetic, Finishing

of this study was to investigate the effect of vitamin E administered subcutaneously to prepartum cows on the incidence of periparturient health problems. A total of 1184 cows in 20 herds were randomly allocated to receive either a single SC injection of 3000 IU vitamin E (d- α -tocopherol) or placebo approximately one week prior to expected calving date. Incidence of peripartum disease (retained placenta, milk fever, metritis, ketosis, displaced abomasum, clinical mastitis, and lameness) was recorded. Data were analyzed in SAS using the GENMOD procedure including herd as a random effect. The risk factors for RP and the effect of vitamin E on RP were different between primiparous and multiparous cows. Therefore, these parity groups were modeled separately. Occurrence of dystocia was offered to the models but was not a signifi-

cant effect. There were no hypersensitive reactions following treatment. Overall, there was no association between vitamin E injection and any disease except RP. Among primiparous animals, treatment reduced the probability of RP by 40% ($P = .06$), with no interactions with season or time of administration relative to calving. Among multiparous cows, occurrence of milk fever or twins were significantly associated with increased risk of RP. Even excluding affected cows, there was no significant effect of vitamin E on the risk of RP in parity 2 or greater. Analysis of the pharmacokinetics of vitamin E in 18 animals suggests that after a single SC injection of 3000 IU, peak circulating vitamin E level is reached in 1 week, and returns to baseline level after 2 weeks.

Key Words: Retained Placenta, Vitamin E, Transition Cow

773 The incidence and impact of clinical endometritis in dairy cows. S. LeBlanc¹, K. Leslie^{*1}, T. Duffield¹, K. Bateman¹, and G. Keefe², ¹University of Guelph, Ontario Veterinary College, ²University of Prince Edward Island, Atlantic Veterinary College.

Endometritis is a localized inflammation and/or infection of the uterus characterized by delayed involution of the uterus, and associated with chronic bacterial uterine infection and purulent uterine discharge. Diagnosis and treatment of endometritis are a source of controversy among veterinarians, fuelled by a lack of large-scale clinical trials with an objective case definition and economically meaningful outcomes. The objectives of this study were to assess diagnostic criteria for endometritis, and to quantify the impact of endometritis on reproductive performance. A total of 1910 cows on 26 farms were studied. The occurrence of dystocia, twins, retained placenta and metritis were recorded. Every cow was examined once between 20-33 DIM, with an external inspection and vaginoscopic examination, followed by rectal palpation of the genital tract for collection of objective data (cervical diameter, location, size, texture and symmetry of the uterus, and ovarian structures). The character of the discharge was scored. Subsequent reproductive performance and culling were monitored for all cows. Multivariate survival analysis was used to identify the factors that predicted longer time to pregnancy (days open), accounting for cows that failed to become pregnant. Adjustment was made for clustering of cows within herds. There were 606 animals (32%) that had visible purulent discharge, but only cows with muco-purulent or worse discharge, or cervical diameter > 7.5 cm after 26 DIM, had significantly reduced pregnancy rate. Using this case definition, the prevalence of endometritis was 21%, and affected cows had an increase of 17 median days open compared to normal cows (140 vs. 123 median days open, respectively). Among cows with endometritis, 69% were diagnosed by vaginoscopy. Given vaginoscopy, only cervical diameter was associated with reduced pregnancy rate; all uterine palpation findings had no predictive value for time to pregnancy. Herd level prevalence of endometritis ranged from 7% to 31%. Endometritis significantly impairs reproductive performance, but identification of affected individuals depends on objective assessment and consideration of the interval from calving to diagnosis.

Key Words: Endometritis, Reproduction, Vaginoscopy

774 The influence of negative energy balance on udder health. K. Leslie, T. Duffield, S. LeBlanc, and J. Ten Hag, University of Guelph, Ontario Veterinary College.

There is growing evidence that the mechanisms of udder defence are impaired in periods of negative energy balance and hyperketonemia. Two recent experiments, involving approximately 1000 periparturient dairy cows in Ontario, were utilized to investigate the association between subclinical ketosis and subsequent mastitis. In the first study, 951 cows were blood sampled at 1, 2, 3, 6, and 9 weeks after calving. Overall, 15.1% of cows (39 of 258) with subclinical ketosis had clinical mastitis, as compared to 10.1% (70 of 693) non-ketotic cows ($p < 0.05$). In cows with ketosis during the first week postpartum, 18.1% had clinical mastitis. In multi-variable regression analysis, it was found that parity, calving in summer and fall seasons, and being ketonemic at a threshold of greater than or equal to 1400mol/L BHB were all significantly associated with an increased risk of clinical mastitis. The associations between subclinical ketosis and elevated SCC were also studied. Of cows with ketonemia for two or more weeks in the postpartum period, 21.6% had an elevated SCC, as compared to 13.6% of cows without chronic ketonemia. In the second study, 1142 cows in 20 herds had blood samples collected during the week before calving and in the first week postpartum. Mastitis

was monitored as a producer diagnosis of clinical signs in the first 30 days in milk. Using this definition, there was 9.7% lactational incidence rate of clinical mastitis (111 cases). Of cows with serum BHB greater than or equal to 1400 mol/L in the week before calving, 28.6% subsequently had clinical mastitis, as compared with 8.7% of cows that were non-ketonemic prepartum. The results of these two studies add to the growing evidence that negative energy balance and subclinical ketosis is associated with increased rates of mastitis.

Key Words: Negative Energy Balance, Subclinical Ketosis, Mastitis

775 The effects of metaphylactic treatment with tilmicosin on the incidence of bovine respiratory disease in growing dairy replacement heifers. D.G. Schmidt^{*1}, J.E. Shirley¹, E.C. Titgemeyer¹, M.V. Scheffel¹, and D.G. McClary², ¹Kansas State University, Manhattan, ²Elanco Animal Health, Greenfield, IN.

One hundred forty four Holstein heifers were used to evaluate the efficacy of a metaphylactic tilmicosin treatment on the incidence of bovine respiratory disease (BRD). Heifers were moved from individual calf facilities at 56 d of age to an off-site (5 h transport) facility, weighed on arrival, ranked by weight, and alternately assigned to pens (6 heifers/pen). Pens with similar weight heifers were paired and randomly assigned to control or tilmicosin treatment. Pens (12/treatment) served as the experimental unit in a randomized block design. Tilmicosin (10 mg/kg of body weight) was administered immediately after pen assignments were completed (day of arrival) to calves in the treatment group. Individuals unaware of treatments conducted health observations twice daily. Incidence of clinical BRD was observed in 2.8 and 4.2 percent of control and tilmicosin treated heifers, respectively. One relapse (clinical signs of BRD within 21 d after treatment) occurred in a tilmicosin treated heifer, and one new episode (clinical signs of BRD after 21 d from first treatment) was observed in a control heifer. Heifers treated with tilmicosin gained more weight ($P < 0.05$), consumed more feed ($P < 0.05$), and were more efficient ($P < 0.05$) during the first 28 d after treatment. Improved performance during the first 28 d in the tilmicosin treated group is presumed to be due to a reduced incidence of sub-clinical BRD.

Key Words: Dairy heifer, Tilmicosin, Bovine respiratory disease

776 On-farm batch pasteurization destroys Mycobacterium paratuberculosis in waste milk. J. Stabel^{*1}, USDA-ARS, National Animal Disease Center, Ames, IA.

A recent dairy survey conducted in 1996 by the National Animal Health Monitoring System suggests between 20 to 40% of dairy herds in the United States have some level of Johne's disease in the herd. This figure will continue to increase unless producers implement management regimes that will help control the spread of this disease within their herd. The neonatal calf is the target for infection with Mycobacterium paratuberculosis, the causative agent of Johne's disease. Calves become infected via exposure to the bacterium through contaminated feces, bedding, colostrum, and milk. Shedding of viable M. paratuberculosis has been documented in the colostrum and milk of infected dams. This study evaluated the efficacy of on-farm pasteurization to destroy M. paratuberculosis in waste milk fed to calves in order to circumvent this mode of transmission. In three replicate experiments, waste milk was experimentally inoculated with M. paratuberculosis and heated at 150degF for 30 minutes. No viable bacteria were recovered after 28 weeks of incubation. These results suggest that batch pasteurization of waste milk contaminated with M. paratuberculosis was effective at generating a clean product to feed to young calves.

Key Words: Mycobacterium paratuberculosis, Johne's disease, Pasteurization

777 Effect of environmental stressors on ADG, serum retinol and α -tocopherol concentrations, and incidence of bovine respiratory disease of feeder steers. N. K. Chirase*^{1,3}, L. W. Greene^{1,3}, C. W. Purdy², R. W. Loan³, R. E. Briggs⁴, and L. R. McDowell⁵, ¹Texas Agricultural Experiment Station, Amarillo and West Texas A&M University, Canyon, ²USDA/ARS, Bushland, TX, ³Texas A&M University, College Station, ⁴USDA/ARS, Ames, IA, ⁵University of Florida, Gainesville.

Environmental stressors are frequently encountered in confined animal feeding operations. An experiment was conducted to determine the effect of Micotil[®] and feedyard dust exposure on ADG, serum vitamins A (Vit A) and E (Vit E) concentrations, and incidence of bovine respiratory disease (BRD) of feeder steers. One hundred and twenty crossbred feeder steers (average BW 185 kg) were purchased in Morristown, TN and transported to Bushland, TX. One half of the steers received Micotil (1 ml/30 kg BW s.c.) in TN. Simulated dust storm was produced by having steers in an enclosed canvas tent. Calves were allotted randomly into 3 dust exposure groups: 1) Control (not exposed to tent or dust), 2) Tent (enclosed in tent without dust) and 3) Dust (exposed to dust suspension inside tent), and nested within Micotil[®] treatments. There were four dust application events each lasting 4 h. Calves were weighed and blood samples taken in Morristown (d -3), arrival (d 0) and every 7 d for 28 d. The data were subjected to the analysis of variance using the General Linear Models procedure of SAS. Transportation stress reduced ($P < 0.001$) serum Vit E concentrations from 7.10 to 1.95 ug/ml. There was no interaction ($P > 0.05$) between the antibiotic and dust treatments. On d-28, the mean ADG of tent and dust groups was lower ($P < 0.02$) than the controls (0.77 vs 1.26 kg/d). Similarly, the mean serum Vit E concentration of these steers was also lower ($P < 0.05$) than the controls (1.88 vs 2.11 ug/ml). Micotil[®] treatment sustained ($P < 0.001$) serum Vit A and E concentrations of steers. As incidence of BRD increased (0 to 6), serum Vit A and E concentrations decreased ($P < 0.001$) as well as ADG. These results suggest that environmental stressors decrease serum antioxidants corresponding with decreases in ADG.

Key Words: Steers, Simulated dust, Serum antioxidants

778 Influence of dietary antioxidant vitamins on performance of feeder steers exposed to simulated feedyard dust. N. K. Chirase*^{1,3}, L. W. Greene^{1,3}, C. W. Purdy², R. W. Loan³, D. R. George¹, and J. Avampato¹, ¹Texas Agricultural Experiment Station, Amarillo and West Texas A&M University, Canyon, ²USDA/ARS Bushland, TX, ³Texas A&M University, College Station.

Feeder cattle often encounter many environmental stressors such as dust. An experiment was conducted to determine the effects of short term (28 d) feeding of vitamins A (Vit A) and E (Vit E) on the performance of beef steers exposed to feedyard dust. Thirty six (36) crossbred feeder steers (average BW 260 kg) were allowed 28 d to recover from transit stress and sickness and assigned randomly into four groups of 9 steers. Steers were housed in pens equipped with calan gate feeders for individual feed intake measurement. The diets consisted of 1) Control (Vit A = 20,240 IU/kg DM; Vit E = 300 IU/kg DM) and 2) Antioxidants (Vit A = 60,700 IU/kg DM; Vit E = 760 IU/kg DM). The diets and dust treatments were arranged in a 2 X 2 factorial design. Steers were trained to feed from calan gates, adapted to diets for 14 d and assigned the following dust treatments: 1) Control (not exposed to tent or dust) and 2) Dust (exposed to dust suspension inside tent). Simulated dust storm was produced in an enclosed canvas tent. There were six consecutive daily dust events each lasting 4 h. Steers were weighed every 8 d. The data were subjected to the analysis of variance using the General Linear Models procedure of SAS. An interaction occurred between the dust and antioxidants for feed intake and ADG on d 8 and 17. Steers fed the control diet and not exposed to dust consumed less ($P < 0.08$) feed and gained less ($P < 0.05$) weight than all other groups. Although not significant ($P > 0.05$), the feed to gain ratio for steers not exposed to dust was 36% greater than those exposed to dust (8.0 vs 5.9). The feed to gain ratios of steers fed the control and antioxidant diets were not different ($P > 0.05$). These results suggest that short term feeding of dietary antioxidants during the receiving period to reduce oxidative stress requires additional investigation.

Key Words: Steer performance, Simulated dust, Antioxidant vitamins

779 Relative contribution of nitric oxide (NO)- synthase (NOS) isoforms to hepatic NO production following low-level in vivo endotoxin (LPS)-challenge in cattle. T. Elsasser*, S. Kahl, E. E. Connor, and D. Carbaugh, USDA, Agricultural Research Service, Beltsville, MD.

Nitric oxide, synthesized from arginine by different isoforms of NOS, mediates many aspects of inflammatory response to bacterial toxins. Type-II NOS, induced primarily in macrophages 4 to 6 h after LPS, has been identified in other cell types as well; Type-III NOS, constitutively present in several cell types, is modulated by cofactor availability. The present research evaluated the temporal relationship between increases in plasma nitrate (NOx, the stable breakdown product of NO) after LPS and relative activity of Type-II and Type-III NOS in liver. Calves were challenged with either 0 (saline, n = 6, CON) or 3 μ g/kg LPS (E. coli 055:B5, iv, jugular, n = 6, L) with serial blood samples obtained for plasma analysis. Plasma NOx increased after 3h ($P < 0.02$) and peaked at 6 to 8 h after a secondary rise initiating at 4 h post LPS. In a subset of calves (n = 4) liver biopsy samples were obtained 8 h after LPS for characterization of NOS isoforms by immunohistochemistry (IHC) and enzyme assay. Localized by IHC, both isoforms were present in CON; less than 5% of cells were positive for Type-II NOS while 36% of cells ($P < 0.002$ vs Type-II) immunostained for Type-III NOS. After LPS, Type-II positive cells increased to 18% in L (hepatocytes, Kupffer cells, and infiltrating monocytes). With the use of selective NOS-type inhibitors both isoforms were identified in CON (2.9% of total NOS activity - Type-II). Type-II activity (pmol citrulline/min/mg protein) averaged 0.052 and 0.445 (SEM = 0.12, $P < 0.002$) in CON and L, respectively. Type-III activity averaged 1.68 and 1.97 (SEM = 0.15, NS) in CON and L, respectively. While the activity of Type-II NOS increased 9-fold with LPS ($P < 0.01$), the relative contribution of Type-II to total NOS activity after this dose of LPS was 18.4%. The data suggest that early increases in plasma nitrate after LPS arise predominantly from Type-III NOS with secondary increases contributed from lower levels of Type-II NOS.

Key Words: Endotoxin, Cattle, Inflammation

780 Influence of estrus on somatic cell count in dairy goats. S McDougall* and M Voermans, Animal Health Centre, Morinsville, New Zealand.

The effect of estrus on the somatic cell count (SCC) in goats' milk was examined by inducing estrus in half of a group of 48 seasonally anoestrus dairy goats. Goats were blocked by infection status and ranked by SCC from the three preceding herd tests and then randomly allocated to three treatment groups: (a) an intravaginal progesterone releasing insert for 12 days and with equine chorionic gonadotropin (eCG) and dinoprost tromethamine 2 days before insert removal (Short; n = 12), (b) an intravaginal progesterone releasing insert for 17 days and with 500 i.u. of eCG on the day of insert removal (Long; n = 12), or (c) left as untreated controls (Control; n = 24). The bacteriological status of each gland of each enrolled goat was determined before and after synchronization (d -23 and d 13) and SCC and milk yield were determined on days -2, 0, 1, 2, 3, 4, 14, 25 where day 0 was the day of intravaginal insert removal. A general linear model was used to test the effect of treatment group on Log₁₀ SCC and milk yield on each day. The value on day -2 was used as covariate in all models. There was no difference in age, SCC or prevalence of intramammary infection preceding synchronisation among treatment groups ($P > 0.1$). The Short group were in estrus before the Long group who were in turn in estrus before the control group (1 (1-1) vs. 2 (2-2) vs. 11 (9-13) days, median days to estrus (upper and lower 95% confidence intervals) for Short, Long and Control groups, respectively; $P < 0.05$). The log₁₀ SCC was higher in the Short than Control group on days 1 to 4 (3.28 +/- 0.10 vs. 2.57 +/- 0.08; 3.17 +/- 0.11 vs. 2.71 +/- 0.08; 2.93 +/- 0.11 vs. 2.63 +/- 0.08; 2.95 +/- 0.12 vs. 2.55 +/- 0.09, mean and sem for Short vs. Control on days 1 to 4, respectively, all $P < 0.05$). Log₁₀ SCC of the Long group were higher than the Control group on days 2 and 4 (3.01 +/- 0.10 vs. 2.71 +/- 0.08; 2.84 +/- 0.11 vs. 2.55 +/- 0.09, mean and sem for Long vs. Control on days 2 and 4, respectively, both $P < 0.05$). There was no difference in milk yield on any day ($P > 0.1$) or in prevalence of intramammary infection between groups. This data indicates that estrus was associated with an increase in SCC and that the increase in SCC was independent of any change in milk yield.

Key Words: Goat, Somatic Cell Count, Estrus

781 Associations between porcine leptin and leptin-receptor marker genotypes and immune parameters. M.F.W. te Pas^{*1}, A.H. Visscher¹, E.J. van Steenbergen², E.F. Knol², K.H. de Greef¹, T.A. Niewold¹, and L.L.G. Janss¹, ¹ID-Lelystad, ²Institute for Pig Genetics.

Leptin is an adipocyte-secreted hormone that affects diverse traits like food intake, body fatness, reproduction, and immune response. Leptin acts through activation of the leptin-receptor on target cells. Leptin deficiency is associated with excessive fatness, suppressed reproductive function, and reduced immune function. Reduced leptin-receptor function is also associated with excessive fatness. Both leptin expression levels and leptin marker genotype has been associated with back fat thickness in certain, but not all, pig breeds. The relationship between leptin and leptin-receptor genotypes and immune parameters is still unknown. The purpose of this study was to evaluate the association between leptin and leptin-receptor genotypes and immune parameters. Ninety immune parameters were measured in 202 AI boars from 4 different lines from 2 pig breeding organizations. Immune parameters were grouped in 1) lymphocyte stimulation tests, 2) lymphocyte cell numbers, and 3) lymphocyte cell membrane markers CD4 and CD8. Pigs were genotyped for 1) a leptin marker as described by Stratil et al. (Anim. Genet. 28: 371-372), and 2) two leptin-receptor intronic PCR-RFLP#s. Associations were evaluated with several statistical models including models that evaluated the association of each individual marker genotype and the immune parameters separately, and models that included the genotypes and interactions of both genes. The results indicate that leptin marker genotypes show good association with the lymphocyte stimulation tests and the cell membrane markers. Leptin-receptor genotypes associated to lymphocyte stimulation tests, lymphocyte cell numbers, and cell membrane markers, but associations were less significant than for the leptin gene. Interactions between the leptin and leptin-receptor genotypes were shown for the cell membrane markers. The relation between pig health and leptin and leptin-receptor genotypes remains to be established.

Key Words: Pig, Leptin Genotype, Immune Capacity

782 Profiling intestinal microbial populations with the *cpn60* molecular diagnostic. J.E. Hill¹, A.G. Van Kessel^{*2}, R.P. Seipp¹, L. Hawkins¹, M. Betts¹, J. Marshall², and S.M. Hemmingsen¹, ¹National Research Council Plant Biotechnology Institute, Saskatoon, SK, ²University of Saskatchewan, Saskatoon, SK.

Conventional methods for identifying and quantifying microorganisms in complex communities such as those found in the intestine are costly, labour intensive, offer limited species differentiating capacity and fail to identify unculturable organisms. We designed a single set of degenerate PCR primers which can be used to amplify a target gene, *cpn60*, present, usually in single copy, in the genomes of all eukaryotes and eubacteria. We used these "universal" primers to characterize the microflora in pig intestine. Total genomic DNA was isolated from pig faeces by two different extraction methods and subjected to universal *cpn60* primer PCR at two different annealing temperatures. The resulting PCR amplicons were cloned, resulting in 4 libraries of partial *cpn60* sequences. To date, 266 randomly selected clones have been sequenced. Analysis showed the presence of 77 distinct sequences appearing in frequencies ranging from 1 to 50 out of 266. The majority of pairwise DNA sequence identities for the sampled sequences were between 50 and 70%, indicating that the sequences likely represent many different genera. A comparison of cloned sequences to a database of *cpn60* sequence data permitted the classification of library sequences into taxonomic subclasses, in some cases to the genus level, consistent with those identified in the intestine by classical methods. Preliminary data suggest that template extraction method and PCR parameters affect the composition and diversity of the resulting library. We are currently collecting sequencing data from 1800 additional library clones and are developing hybridization and realtime PCR approaches to quantitatively profile intestinal bacterial colonization. Profiling technology based on *cpn60* has significant potential to improve understanding of the interrelationships among intestinal colonization, age, nutrition, health status and animal performance.

Key Words: Intestinal Microbiology, *cpn60*, Molecular Diagnostic

783 Evidence for Transfer of Tylosin and Tylosin-Resistant Bacteria in Air from Swine Production Facilities using Sub-Therapeutic Concentrations of Tylan in Feed. J. A. Zahn^{*}, J. Anhalt, and E. Boyd, National Swine Research and Information Center, USDA-ARS, Ames, IA.

Macrolides are an important class of antibiotics used in human and veterinary medicine for therapy and prevention of diseases caused by Gram-positive bacteria, and as animal growth promotants. Tylosin belongs to the class of 16-membered macrolide antibiotics, and has been used exclusively in veterinary medicine for treatment of animal diseases or for enhancing animal growth rate. Antibiotic resistance studies have recently focused on tylosin residues and tylosin-resistant bacteria (TRB) in animal products or in effluent streams from animal production facilities as potential routes for transfer of antibiotic resistance to humans. However, these studies have not considered aerial transfer from point sources as a significant route in human exposure. This study quantified the concentration of tylosin and TRB in air from three mechanically ventilated swine (finisher stage) confinements using tylosin at sub-therapeutic concentrations ($20 \text{ g} \cdot \text{ton}^{-1}$) in feed. Tylosin residues and culturable bacteria in air at exhaust fans were trapped on absorbent resins or impinger samplers, respectively. Tylosin concentration was determined by high-performance liquid chromatography-electrospray tandem (MS-MS) mass spectrometry following solvent desorption of absorbent resins. The number of culturable bacteria and culturable, TRB were determined by plating on standard plate count agar containing no tylosin or $50 \mu\text{g} \cdot \text{mL}^{-1}$ tylosin, respectively. The mean concentration of TRB ($49,400 \text{ } 16,700 \text{ CFU} \cdot \text{m}^{-3}$) accounted for approximately 80% of the total culturable bacteria ($62,100 \text{ } 18,300 \text{ CFU} \cdot \text{m}^{-3}$) present in air streams from confinements, with *Corynebacterium* the predominant genus of TRB. The mean concentration of tylosin in the air from the three confinements was shown to be $8.1 \text{ } 5.3 \text{ ng} \cdot \text{L}^{-1}$ of exhaust air. Feeder operation, ventilation rate, and animal activity were shown to be the most significant variables influencing emission rate of tylosin and culturable TRB from the swine confinements. The results indicate that aerial transfer of antibiotics and antibiotic-resistant bacteria from swine confinements may represent an important, and previously overlooked mechanism for transfer of antibiotic resistance to humans and to the environment.

Key Words: Antibiotic Resistance, Tylosin, Swine Production

784 Evaluation of Mannan Oligosaccharide on the microflora and immunoglobulin status of sows and piglet performance. K. E. Newman^{*1} and M. C. Newman², ¹Venture Laboratories, Inc., Lexington, KY, ²University of Kentucky, Lexington, KY.

A number of studies have demonstrated improvements in production parameters and mortality with the inclusion of Mannan oligosaccharide (MOS) to the diet. Documented effects include increased macrophage activity and serum immunoglobulins. In addition, alterations in fecal bacterial populations have also been noted with MOS inclusion in the diet. Twenty-four sows were divided into two treatment groups by parity to evaluate the effect of MOS on fecal bacterial populations, sow colostrum immunoglobulin levels and piglet performance to weaning. All sows received a fortified corn-soy diet. Treated sows received 5-g MOS per day from approximately 14 days pre-farrowing throughout the lactation. Control sows received no supplementation (C). MOS treated sows had higher levels of IgM than untreated sows (440 vs. 316 mg/dl; $P=0.0366$). Colostrum IgG levels were also numerically increased in sows receiving MOS (4215 vs. 3565 mg/dl; $P=0.1615$). Colostrum immunoglobulin levels were also numerically greater 24-h post-farrowing in sows receiving MOS than unsupplemented sows (IgG 1572 vs. 1130 mg/dl; IgM 227 vs. 184 mg/dl). No effect of MOS supplementation was noticed on colostrum IgA concentrations. Piglet mortality was unaffected by treatment. Piglet weights were determined at 7, 14 and 21 days and greater when sows were supplemented with MOS than unsupplemented sows (Day 7: C - 3.14kg, MOS - 3.61kg; Day 14 C - 4.92kg, MOS - 5.62kg; Day 21 C - 6.57kg, MOS - 7.61kg $P<0.05$). Sow fecal bacterial concentrations were unaffected by treatment. The exact mechanism of the improved performance seen in the piglets from sows receiving MOS is not fully understood, but improved immune status of the piglets may provide an aid in performance by controlling sub-clinical problems. Further investigations on the nutrient profiles of colostrum may be warranted to better explain improved piglet performance.

Key Words: mannan oligosaccharide, immunoglobulin, sow

785 Biosecurity measures of spray-dried plasma protein in weanling pigs. J.M. Campbell*¹, B.S. Borg¹, L.E. Russell¹, J. Polo¹, and J. Pujols², ¹APC, Inc., Ames, IA, ²CRESA, Barcelona, Spain.

The experimental objective was to evaluate safety of spray-dried plasma protein after oral administration in weanling pigs by monitoring clinical, serological, and performance results. Thirty-six pigs (13.6 kg body weight) were randomly assigned to dietary treatments consisting of control (soybean meal) or 8% plasma. Diets were formulated to contain 1.20% lysine due to continuous administration for 2 months after weaning. Individual body weights and feed intake were determined on d 0, 21, 42, and 63 post-weaning. Clinical observations were monitored daily. Blood samples were obtained on d -14, 0, 21, 42, and 63 post-weaning for serological testing. Average daily gain was improved ($P < 0.10$) from d 22-42 and 0-42 due to plasma consumption compared

ASAS/ADSA Breeding and Genetics: QTL Detection and Mapping

786 Fine scale mapping of QTL using of linkage and linkage disequilibrium. T.H.E. Meuwissen*¹ and M.E. Goddard^{2,3}, ¹Institute fo Animal Science & Health, Lelystad, The Netherlands, ²University of Melbourne, Melbourne, Australia, ³Victoria Institute of Animal Science, Melbourne, Australia.

Genome wide scans for QTL in livestock populations have revealed many QTL carrying chromosomal regions. However, the size of these regions is rather large: $> 30\text{cM}$. Linkage disequilibrium has proven useful for the fine mapping of mono-factorial diseases in humans. A Quantitative Trait Loci (QTL) mapping method is presented that combines the information from linkage analysis and linkage disequilibrium mapping. The method is based on predicting an Identity By Descent (IBD) probability matrix between all haplotypes of the animals at the putative QTL position. By using this IBD-matrix as a correlation matrix between haplotypes, the variance associated with the putative QTL and the likelihood of the data can be estimated using REML variance component estimation. This likelihood can be maximised over all putative QTL positions in order to find the maximum likelihood position of the QTL. The matrix of IBD probabilities is predicted using 1) the identities of marker alleles in the region surrounding the QTL (linkage disequilibrium information); 2) recombinations within the marker haplotypes that occurred in the genotyped and pedigreed animals (linkage analysis information). The information on the IBD probabilities comes from two parts of the pedigree: 1) say 100 early generations where no pedigree and no genotyping information is available (but effective population size was assumed known); 2) say 2-5 generations where pedigree and genotypes are available. Background genes are accounted for by including a polygenic term in the REML variance component estimation.

Key Words: fine scale mapping, linkage analysis, linkage disequilibrium

787 Evaluation of statistical models and permutation tests for detecting gametic imprinting in QTL scans. H. K. Lee¹, J. C. M. Dekkers*², R. L. Fernando², and M. F. Rothschild², ¹National Livestock Research Institute, Korea, ²Iowa State University, Ames, IA.

Recently, De Koning et al. (PNAS, 2000) detected imprinted QTL in an F2 swine breed cross based on significance of paternal and maternal imprinting effects against a no-QTL model. They did, however, not test for deviations from Mendelian inheritance. Our objective was to develop and evaluate such tests. Breed cross regression interval mapping was implemented using the following QTL models: Mendelian (additive and dominance effects), full imprinting (separate maternal and paternal allele effects plus dominance), paternal imprinting (only paternal expression), and maternal imprinting. Tests of each model against the no-QTL model and tests of full imprinting against the Mendelian (Full/Mend), paternal and maternal imprinting models were used in a decision tree to determine presence and mode of inheritance of QTL. Chromosome-wise significance levels were derived by permutation (20,000 replicates). For the Full/Mend test, data were permuted by shuffling paternal against maternal coefficients within individual. Permutation test thresholds were compared to true values obtained from replicate (10,000) simulation of data under the null hypotheses (512 progeny from 8 F1 sires and 32 dams). The QTL was either fixed in alternate breeds or segregating at different frequencies (.7 and .3). The Full/Mend test had

to control pigs. Average daily feed intake and feed efficiency tended towards ($P > 0.10$) improvement. During the experiment, no clinical signs were associated with oral plasma consumption; however, control pigs had mild clinical symptoms and one death. Serological results of all blood samples from control and plasma treated pigs were negative for antibody presence against the following viruses: porcine parvovirus (PPV), Aujeszky's disease virus (PRV), porcine respiratory and reproductive syndrome virus (PRRS), and bovine viral diarrhoea virus (BVD). The plasma used in the study was devoid of titers for PRV, PRRS, and BVD, but positive for PPV. In summary, results indicate that oral administration of plasma had no adverse effects on clinical or performance parameters. Serological results indicate no transmission of disease from plasma for the period from a 14 to 63 kg pig.

Key Words: pigs, spray-dried plasma protein

higher F-value significance thresholds than tests against the no-QTL model. For fixed QTL, thresholds for Full/Mend derived by permutation underestimated simulated 10, 5, and 1% chromosome-wise type I error rates, but by less than 1.5, 0.6, and 0.3%. Simulation thresholds were slightly more stringent for segregating QTL. As a result, the permutation test underestimated simulated type I error rates slightly more ($< 1\%$). Similar work is ongoing to validate tests of full against paternal or maternal imprinting. In conclusion, statistical models and permutation tests can be used to determine presence and mode of inheritance of QTL, although true type I error rates may deviate slightly from desired rates. Supported by USDA CSREES # 00-52100-9610.

Key Words: QTL detection, Imprinting, Permutation test

788 A Bayesian approach for constructing genetic maps when genotypes are miscoded. G. J. M. Rosa*^{1,2}, B. S. Yandell², and D. Gianola², ¹UNESP - Botucatu, SP/Brazil, ²UW - Madison, WI.

The increased availability of information on genetic markers has created opportunities for understanding quantitative inheritance and for developing novel strategies for genetic improvement in agriculture, such as exploitation of quantitative trait loci (QTL). A QTL analysis relies on having accurate genetic marker maps. At present, however, statistical methods for map construction ignore the possibility that molecular data are read with error. Often, there is ambiguity about at least some genotypes, and ignoring this phenomenon can affect inferences adversely. Here, a Markov chain Monte Carlo Bayesian approach is presented for constructing genetic maps (gene ordering and genetic distances) when there is some random miscoding of genotypes. A probability of miscoding is incorporated in the calculation of recombination events, assuming Haldane's mapping function. Samples from the joint (conditional) posterior distributions of recombination rates and gene order are obtained with the Metropolis-Hastings algorithm. Missing marker genotypes are imputed from Bernoulli distributions. Backcross data sets were simulated, with 100 or 300 individuals, genotyped for 5 loci (including some missing data), and with recombination rates between adjacent loci ranging from .02 to .18. Miscoding probabilities were 0, 2, 4 and 5%. Analyses were conducted ignoring or contemplating miscoding in the model. Results indicate that unless there is certainty that genotypes are coded correctly, it may be safer to use our alternative, robust, procedure, as it provides more reliable inferences about genetic maps. An analysis of *Brassica napus* is presented to illustrate how the procedure works in practice.

Key Words: Genetic map, Miscoding genotype, Bayesian inference

789 The extension of mixed model equations to finite normal mixture models for marker assisted analysis of quantitative traits. Yuefu Liu*, University of Guelph, Guelph, Canada.

The marker-based analysis of quantitative traits, such as marker assisted genetic evaluation, is characterized by the mixture model since the QTL genotypes are not observable. It is, therefore, important to develop a general statistical procedure for mixture model analysis. In this study, a set of mixture model equations was derived based on the normal

mixture model and the EM algorithm to analyze the data with mixture distributions. The derived equations are a generalization of Henderson's mixed model equations for mixture models. The mixture model equations were applied to marker assisted genetic evaluation with different parameterizations of QTL effects. The sire-QTL-effect model and the founder-QTL-effect model were introduced to illustrate the utilization of the mixture model equations. The potential advantages of the mixture model equations for marker assisted genetic evaluation were discussed. Comparing with mixed model equations, the mixed effect mixture model equations are flexible in modeling and shows desirable properties in estimating QTL effects.

Key Words: Normal mixture model equations, EM algorithm, Marker assisted genetic evaluation

790 Parameter estimation of epistasis effects using orthogonal marker contrasts. Yang Da*, *Department of Animal Science, University of Minnesota.*

The epistasis effects of two QTLs can be detected and mapped through their linked markers. Assuming marker A is linked to QTL 1 and marker B is linked to QTL 2, the marker genotypic effects can be obtained from the following model, $y = X\beta + Zm + \epsilon$, where $X\beta$ represents fixed non-genetic effects, $Z = nx9$ model matrix, $m = (AABB, AABb, AAbb, AaBB, AaBb, Aabb, aaBB, aaBb, aabb) = 9x1$ column vector of the genotypic effects of two-marker genotypes, and $\epsilon =$ random residuals including recombination residuals of the QTL value. Then, a QTL effect can be tested using an orthogonal marker contrast of $c_i m$, where c_i is one of the following eight contrasts: $c_1 = (1, 1, 1, 0, 0, 0, -1, -1, -1) =$ additive contrast for QTL 1, $c_2 = (-1/2, -1/2, -1/2, 1, 1, 1, -1/2, -1/2, -1/2) =$ dominance contrast for QTL 1, $c_3 = (1, 0, -1, 1, 0, -1, 1, 0, -1) =$ additive contrast for QTL 2, $c_4 = (-1/2, 1, -1/2, 1, -1/2, -1/2, 1, -1/2) =$ dominance contrast for QTL 1, $c_5 = (1, 0, -1, 0, 0, 0, -1, 0, 1) =$ additive additive contrast, $c_6 = (-1/2, 1, -1/2, 0, 0, 0, 1/2, -1, 1/2) =$ additive dominance contrast, $c_7 = (-1/2, 0, 1/2, 1, 0, -1, -1/2, 0, 1/2) =$ dominance additive contrast, $c_8 = (1/4, -1/2, 1/4, -1/2, 1, -1/2, 1/4, -1/2, 1/4) =$ dominance dominance contrast. Based on the above contrasts, analytical formulae are derived for estimating QTL locations and the size of each epistasis effect.

Key Words: Epistasis effect, Orthogonal marker contrast, QTL parameters

791 The effect of the number of loci on genetic evaluations in finite locus models. L.R. Totir*, R.L. Fernando, and S.A. Fernandez, *Iowa State University, Ames, IA.*

Several traits of interest are known to have low heritability, suggesting a non-additive gene action. Best linear unbiased prediction (BLUP) methods, although extremely efficient under additive gene action, have computational problems for large pedigrees under non-additive gene action. Multibreed data further increases the complexity of this problem. Finite locus models have been investigated recently as an alternative to infinitesimal models for genetic evaluation. A finite locus model can easily accommodate non-additive gene action even for multibreed data. Given a finite locus model, Markov Chain Monte Carlo (MCMC) methods can be used to estimate the posterior mean of genotypic values. Successful application of MCMC methods for genetic evaluation depends, among other factors, on the number of loci assumed in the model. In order to investigate the effect of the number of loci on genetic evaluations obtained with finite locus models, purebred as well as multibreed data were simulated for a 20-locus model. For a small pedigree, genetic evaluations obtained by best linear prediction (BLP) were compared to those from 1, 2, and 3-locus models. For BLP evaluations, the required parameters are the first and second moments of the joint distribution of the genotypic and phenotypic values. These moments were calculated from the gene frequencies and genotypic effects used in the simulation. For finite locus evaluations, the required parameters are the gene frequencies and effects for each locus in the analysis model. These were defined such that they yield the same first and second moments as the 20 locus model. For the 1, 2, and 3-locus models, exact posterior means were calculated using SALP, a segregation and linkage analysis computer program. As the number of loci increased, the finite locus genetic evaluations were closer to the BLP evaluations. Evaluations from the 2-locus model provided a good approximation to those from BLP. The improvement brought by the use of 3 loci was limited. So far only up to 3-locus models have been considered, which is the upper limit for

SALP. An MCMC sampler, known as ESIP will be used to investigate models with more than 3 loci in order to find the model that yields robust results and is still computationally efficient.

Key Words: Finite locus model, Markov Chain Monte Carlo, Best linear unbiased prediction

792 Accuracy of marker assisted selection using a mixed model method. Mathew A Chrystal*, Yang Da, Leslie B Hansen, and Antony J Seykora, *Department of Animal Science, University of Minnesota.*

The accuracy of marker assisted selection (MAS) was evaluated using a mixed model method and simulated data with known true QTL effects and marker-QTL distances. Correlation between the predicted marker effects and the true QTL values (r_1) was compared with the correlation between the phenotypic value and the true QTL values (r_2) for heritabilities (h^2) ranging 5% 30%. Also, the frequency of the favorable QTL allele in the selected population based on MAS is compared to that based on phenotypic selection for heritabilities ranging 5% 30% and for percentage of selected individuals (PSI) ranging 5% 30%. The correlation between the predicted marker effects and the true QTL values were substantially higher than that between the phenotypic and true QTL values, particularly when heritability is low. For example, for $h^2 = 30\%$, $r_1 = 0.726$, $r_2 = 0.548$; for $h^2 = 5\%$, $r_1 = 0.718$, $r_2 = 0.224$. Furthermore, MAS results in higher frequency of the favorable QTL allele in the selected population than phenotypic selection. Let $p_1 =$ frequency of individuals with the favorable QTL allele using MAS, and $p_2 =$ frequency of individuals with the favorable QTL allele using phenotypic selection. For the same PSI value of 5%, $p_1 = 0.996$ and $p_2 = 0.961$ if $h^2 = 30\%$, and $p_1 = 0.973$ and $p_2 = 0.728$ if $h^2 = 5\%$. For the same heritability of 5%, $p_1 = 0.973$ and $p_2 = 0.728$ if PSI = 5%, and $p_1 = 0.948$ and $p_2 = 0.630$ if PSI = 30%. In summary, MAS is most helpful when phenotypic selection is least effective, i.e., when heritability is low and the percentage of selected individuals is high.

Key Words: Marker assisted selection, QTL, Mixed model

793 Improved resolution of the porcine-human comparative genetic map. G. A. Rohrer*, S. C. Fahrenkrug, E. M. Campbell, J. W. Keele, and B. A. Freking, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE, USA.*

The last comprehensive porcine genetic map published by the MARC contained 1,042 loci and spanned an estimated 98.6% of the genome. Unfortunately, development of a high resolution human-swine comparative map was not possible as only 46 loci were associated with protein coding sequences (genes). Since that time, most marker development at MARC have been focused on increasing the number of genes represented on the porcine genetic map. Many of these markers were developed by screening porcine genomic libraries for specific genes and then identifying microsatellite markers within the identified clones. Our recent research emphasis has been to map genetic markers associated with porcine expressed sequence tagged (EST) sequences developed at MARC. Some ESTs were mapped using informative microsatellite markers identified within the sequences. Most ESTs have been mapped by identification of single nucleotide polymorphism (SNP) markers. In total more than 200 gene associated loci have been genotyped across the MARC reference population since the last published map, increasing the number of comparative anchor loci to nearly 250. Based on these gene assignments inferences about the conservation of synteny and gene order during the evolution of man and pigs can begin to be developed. In general, the predicted chromosome location of a gene has agreed with bi-directional ZOO-FISH results. The degree of conserved gene order varies widely across different chromosomes. In particular, SSC X appears to have an identical gene order as HSA X, while the gene orders within the conserved syntenic segments of SSC 5 and HSA 12 are quite different. Some ESTs have not mapped to the predicted porcine chromosomes which may be caused by incorrect determination of the human orthologue or previously undetected chromosomal rearrangements. Our efforts in mapping porcine genes has increased the marker density of the porcine genetic map as well as significantly improved the resolution of the porcine-human comparative map. The improved comparative map facilitates use of the human map to select positional candidate genes in QTL studies.

Key Words: Pig, Gene mapping, Comparative map

794 Effects of the Porcine Melanocortin 4 Receptor gene on growth rate, feed conversion and carcass composition of pigs sired by PIC337 or PIC408 boars. S. Jungst*¹, E. Wilson¹, M. Rothschild², C. Booher¹, T. Pastor¹, B. Fields¹, and G. Plastow¹, ¹PIC USA Franklin, KY, ²Iowa State University, Ames.

Camorough 22 and 24 sows were inseminated with semen from PIC337 (N=9) or PIC408 (N=10) boars to produce pigs to examine the effects of the Melanocortin 4 Receptor (*MC4R*) gene. Boars were randomly selected within line and their *MC4R* genotypes were unknown. Fifteen pigs were allotted to pens with either 13.4 or 8.4 m² of floor space during the growing - finishing period. Pigs were allotted to pens so each sire line and *MC4R* genotype was represented in the finisher pens. A total of 718 pigs from 102 litters were started on test. Objectives were to: 1) estimate *MC4R* additive effects, 2) determine if the marker effect was the same in each sire line and 3) determine if the gene effects were different for the two floor space allowances. SAS PROC MIXED was used to complete the analyses. Fixed effects for sire line, dam line, sire line x dam line, *MC4R* genotype, floor space and sex were included in all models. Boars nested within sire line and sows nested within dam line were included as random effects. Average daily gain, feed intake and feed conversion were adjusted for on-test weight. Carcass traits were adjusted for carcass weight. Sire line x *MC4R* and floor space x *MC4R* interactions were not detected for any trait (P>.10). The *MC4R* genotype that reduced fat thickness was deemed the favorable genotype. *MC4R* additive effects were -13 g/d for average daily gain (P<.10), -.07 kg/d for feed intake (P<.05), -.6 mm for real-time backfat (P<.05) and .7 mm for real-time loin depth (P<.10). Additive effects were .11 kg (P<.05), .09 kg (P<.05), .04 kg (P<.10) and -.06 kg (P<.10) for ham, loin, shoulder and belly weight, respectively. *MC4R* additive effects were -.5 mm for carcass backfat thickness and .2% for primal percentage (P<.05). These results confirm and extend the initial findings of Kim *et al.* (2000 Mamm. Gen. 10 p131-135). This gene can be used to produce leaner and more efficient pigs.

Key Words: Pigs, *MC4R*, Growth

795 Genetic relationships between insulin-like growth factor-I and performance traits in two lines of purebred swine. K.G. Lahti*¹, K. Bunter², J. Mercer¹, and S. Clearkin³, ¹Bell Farms, Wahpeton, North Dakota, ²University of New England, Armidale, NSW, ³PrimeGRO Pty. Ltd., Thebarton, South Australia.

Insulin-like growth factor-I (IGF-I) measured in the blood of weaning piglets is a suggested predictor of feed efficiency and carcass performance. Blood card samples were collected for IGF-I analysis in the nursery of a breeding company nucleus from 606 Landrace (LA) and 600 Large White (LW) piglets at 27 to 36 days of age. Samples were from 377 boars and 829 gilts, weaned at an average of 17 days. IGF-I assays were performed by PrimeGRO Pty. Ltd. Some pre-selection of boars for castration and feeder pigs for sale occurred before pigs began performance testing at 90 to 101 days of age. Valid daily feed intakes were measured on 124 boars with Osborne Industries Feed Intake Recording Equipment (FIRE feeders) and used to calculate feed conversion ratios (FCR). Pigs completed testing at 160-183 days of age, with weights and real-time ultrasound measurements of last-rib backfat (BF) and muscle depth collected on all pigs to compute gains and lean tissue growth rate (LTGR). Data were analyzed using SAS PROC GLM and ASREML. For LA and LW, univariate estimates of heritability were respectively, .09(.04) and .13(.04) for FCR, .44(.12) and .59(.11) for IGF-I, .38(.02) and .37(.02) for BF, and .26(.02) and .24(.02) for LTGR. Genetic correlations obtained with bivariate analyses of IGF-I with BF were .49(.15) and .54(.14), with FCR were .50(.38) and .59(.40), and with LTGR were -.25(.18) and -.20(.18) for LA and LW. The large, positive genetic correlations between IGF-I and BF indicate that animals with high IGF-I at weaning are more likely to be fatter at finishing. This is consistent with the strong positive genetic correlations found between IGF-I and FCR, and moderate negative genetic correlations between IGF-I and LTGR. Despite low numbers of feed records, results correspond in size and magnitude with previous studies. IGF-I may be a useful tool for early selection of boars and for obtaining increased accuracy of breeding values for feed intake and efficiency.

Key Words: Insulin-like Growth Factor-I, Swine

796 Interval mapping detection of QTL influencing lactation patterns in Holstein cattle. S. L. Rodriguez-Zas*, B. R. Southey, H. A. Lewin, and D. W. Heyen, *University of Illinois, Urbana, IL.*

Quantitative trait loci (QTL) affecting the shape and scale of the lactation curve of production and health indicators in dairy cattle were located using microsatellite marker data. Information on 46 genetic markers distributed across bovine chromosomes 3, 6, 7, 14, 21 and 22 was available from a total of 475 sons in three Holstein families. This information was combined with protein and somatic cell score (SCS) monthly records following a granddaughter design. A nonlinear mixed effects model was used to portray the lactation curve patterns. The probability of receiving either QTL allele from the grandsire was computed at 1cM intervals using an interval-mapping approach. Estimates of the putative QTL effect were obtained at the most likely position and significance values were adjusted for multiple testing. The implemented approach uncovered QTL associated with considerable variation of the lactation patterns. Some positions were associated with significant variation of various descriptors of the lactation curve. For example, a QTL located 69-79 cM on chromosome 6 was associated with variation on both the shape and scale of the protein lactation curve in one family. Other QTL exerted their effect on one or two curve parameters, such as a QTL located 61 to 71 cM on chromosome 3. Detected QTL can be used in marker assisted selection schemes to modify lactation patterns for more efficient production. This innovative approach enhances the understanding on the genetic control of the different aspects of the lactation curve and can be applied to other longitudinal traits.

Key Words: Monthly records, Non-linear model, Repeated measurements

797 A genome scan to identify quantitative trait loci affecting economically important traits in an elite US Holstein population. M.S. Ashwell*, C.P. Van Tassell, and T.S. Sonstegard, *USDA, ARS Gene Evaluation and Mapping Laboratory.*

Quantitative trait loci (QTL) affecting economically important traits were studied for eight Dairy Bull DNA Repository large US Holstein grandsire families using the granddaughter design. A total of 155 microsatellite markers located throughout the bovine genome were selected for the scan. Effects of marker alleles were analyzed for 22 traits including traits for milk production, somatic cell score, productive life, conformation and calving ease. Permutation tests were used to calculate empirical trait-wise error rates. A trait-wise critical value of P = 0.1 was used to determine significance. Twelve chromosomes (BTA) had significant marker-trait associations identified from within- and across-family analyses. Two chromosomes (BTA6 and 14) had significant effects on milk composition traits and BTA7 had a significant effect on somatic cell score. Significant effects on conformation traits, especially rump angle, were found on 8 bovine chromosomes (BTA4, 9, 12, 14, 16, 18, 22 and 27). The QTL identified in this genome scan may be useful for marker-assisted selection to increase the rate of genetic improvement on traits such as disease resistance and conformation traits associated with fitness while maintaining or accelerating genetic improvement for production. Before incorporation in marker-assisted selection programs, these potential QTL must be validated in other populations or newer generations of the original families. Validation studies are underway for QTL affecting dairy form and protein percentage on BTA27 and 6, respectively.

Key Words: Quantitative Trait Loci, Conformation traits, Dairy cattle

798 Detection of quantitative trait loci for functional and conformation traits in a whole genome scan in dairy cattle. H Thomsen*¹, N Reinsch², M Schwerin³, G Erhardt⁴, and E Kalm², ¹Department of Animal Science, Iowa State University, Ames, ²Institut fuer Tierzucht und Tierhaltung, D-24098 Kiel, ³Forschungsinstitut fuer die Biologie landwirtschaftlicher Nutztiere, D-18196 Dummerstorf, ⁴Institut fuer Tierzucht und Haustiergenetik, D-35390 Giessen.

A granddaughter design, consisting of 16 German Holstein grandsires and 872 sons, was used to locate quantitative trait loci (QTL) that affect functional and conformation traits in dairy cattle. The data was part of the granddaughter design of the joint German QTL research effort of AI organisations, breeding organisations and several institutions of animal breeding. Grandsires and sons were genotyped for 247 microsatellite

markers, 8 SSCP polymorphisms, 4 protein polymorphisms, and 5 erythrocyte antigen loci covering the whole genome. De-regressed breeding values were available for 29 traits, including 20 conformation, 2 fertility, 4 birth, 2 workability, and 1 longevity trait. After determining the most likely marker haplotypes for all grandsires based on the genotypes of their sons, multi-marker regression analysis of the trait data was used to scan the genome for QTL. Chromosome-wise and experiment-wise significance thresholds were determined by permutation test. The test statistic exceeded the genome-wise significance threshold with a type I error of less than 10% for the following traits and chromosomes: rump width on chromosome 1; feet and legs, foot angle, teat placement, udder, and udder depth on chromosome 6; calving difficulties on chromosome 8;

teat length on chromosome 13; rate of stillbirth on chromosome 18, and milking speed and temperament on chromosome 29. All QTL on chromosome 6, that exceeded the genome-wise significance threshold, were located around 88 cM. QTL for rump width on chromosome 1 may have an effect on calving difficulties. QTL for udder traits on chromosome 6 and 13 may affect somatic cell score and mastitis resistance. If there are no unfavorable correlations with other economic traits, marker assisted selection using markers associated with these QTL can be applied.

Key Words: whole genome scan, quantitative trait loci, conformation and functional traits

ASAS/ADSA Growth and Development: Conjugated Linoleic Acid (CLA) in Milk Production, Growth, and Health

799 Conjugated linoleic acid (CLA) and lipid metabolism in lactating cows. D. E. Bauman^{*1}, L. H. Baumgard, B. A. Corl, E. Matitashvili, D. G. Peterson, J. W. Perfield II, and M. A. Madron, ¹Cornell University.

The uniqueness of CLA in ruminant fat relates to biohydrogenation of unsaturated fatty acids by rumen bacteria. The major CLA isomer is *cis*-9, *trans*-11 and recent work with animal models has established that this isomer is anticarcinogenic when provided as a natural component of food. Although some CLA is of rumen origin, the major source in lactating cows is endogenous synthesis via Δ^9 -desaturase from *trans*-11 C18:1, another biohydrogenation intermediate. Thus, fat content of CLA is a function of rumen outflow of CLA and *trans*-11 C18:1, plus tissue activity of Δ^9 -desaturase. Investigations of these aspects have identified dietary manipulations, regulatory processes and animal differences that can impact the CLA content of ruminant fat. Under certain conditions, the initial step in linoleic acid biohydrogenation is altered so the isomerization results in production of *trans*-10, *cis*-12 CLA. This CLA isomer affects lipid metabolism during growth and lactation. Across a range of diets a curvilinear relationship exists between the increase in milk fat content of *trans*-10, *cis*-12 CLA and the reduction in milk fat yield. Thus, rumen biohydrogenation can result in the formation of *trans*-10, *cis*-12 CLA, and possibly other unique biohydrogenation intermediates that are potent inhibitors of milk fat synthesis; we refer to this as the "biohydrogenation theory" of milk fat depression. *Trans*-10, *cis*-12 CLA is a potent inhibitor of milk fat synthesis with 3.5 g/d (0.016% dietary dry matter) resulting in a 25% reduction. Yields of all milk fatty acids are reduced, but effects are especially pronounced on those fatty acids originating from *de novo* synthesis and Δ^9 -desaturase activity. Although specific mechanisms are not well defined, recent investigations indicate that exogenous *trans*-10, *cis*-12 CLA causes substantial reductions in mammary tissue mRNA abundance for key enzymes associated with *de novo* fatty acid synthesis, uptake of preformed fatty acids, fatty acid transport and esterification, and plasticity of milk fat.

Key Words: CLA, fat, milk fat

800 The use of rumen-protected conjugated linoleic acid to reduce milk fat percentage in lactating dairy cattle. M.A. Sippel^{*1}, J.P. Cant¹, and R. Spratt², ¹University of Guelph, Guelph, Ontario, ²Agribands Purina Canada, Woodstock, Ontario.

The use of conjugated linoleic acid (CLA) has been shown to reduce milk fat secretion in dairy cattle. A rumen-protected source of CLA is required for commercial feed applications. To test the ability of different rumen-protected CLA sources to induce milk fat depression, four Holstein cows (avg. 77 DIM, 40.9 kg/d milk, parity 2.25) were randomly assigned to treatments in a 4 x 4 Latin Square design. Treatments were a control diet (0 g CLA/d), CaCLA salt providing 50 g CLA/d, GRAS-coated providing 50 g CLA/d, and liquid CLA oil providing 50 g CLA/d. Periods were 3 weeks of adjustment and 1 week of sampling. The CaCLA and liquid CLA oil caused 23.4 and 23.9% depressions in milk fat content, respectively, without affecting milk, protein or lactose yields, or dry matter intake. In a second experiment, CaCLA was fed to provide 0, 25, 50, 75 or 200 g CLA/d. Ten Holstein cows were divided into two 5 x 5 Latin Squares by parity number; square 1 multiparous (avg. 110 DIM, milk yield 35.9kg/d, parity 2.3), square two primiparous (avg. 103 DIM, milk yield 29.3kg/d). Periods were 3 weeks of adjustment, followed by 1 week of sampling. Milk fat content averaged 3.48, 2.84, 2.53, 2.47 and 2.19 % as CaCLA intake increased from 0 to 200 g CLA/d. Milk yield

was reduced by 2.19 kg/d on the 200g CLA/d treatment relative to the control. There was no effect of treatment on dry matter intakes or milk protein and lactose percentages. There was no significant difference in response due to parity. Feeding the CaCLA salt source to provide 25 to 75 g CLA/d was effective in decreasing milk fat percentage without affecting other production variables.

Key Words: conjugated linoleic acid, milk fat, rumen protection

801 Milk fat synthesis in dairy cows is progressively reduced by increasing amounts of *trans*-10, *cis*-12 conjugated linoleic acid (CLA). Lance H. Baumgard^{*}, Jodi K. Sangster, and Dale E. Bauman, Cornell University.

CLA supplements containing a variety of isomers reduce milk fat yield in a number of species. We have recently identified *trans*-10, *cis*-12 as the CLA isomer responsible for inhibiting milk fat synthesis in dairy cows (Baumgard et al. Am. J. Phys. 278:R179). Our objectives were to establish a dose-response relationship between *trans*-10, *cis*-12 CLA and milk fat synthesis, and relate effects on milk fatty acid composition to the potential mechanism of action. Multiparous Holstein cows in late lactation were used in a 4 x 4 Latin square design where treatments consisted of four doses of *trans*-10, *cis*-12 CLA: 1) 0.0 g/d, 2) 3.5 g/d, 3) 7.0 g/d, and 4) 14.0 g/d. Over the 5d treatment intervals doses were continuously infused into the abomasum as a convenient experimental means to avoid possible alterations by rumen microbes. Milk fat yield was decreased 25, 33, and 50%, and milk fat concentration was reduced 24, 37 and 46% when cows received 3.5, 7.0 and 14.0 g/d of *trans*-10, *cis*-12 CLA, respectively. Feed intake, milk yield and milk protein content and yield were unaffected by treatment. Milk fat content of *trans*-10, *cis*-12 CLA averaged < 0.1, 1.5, 3.2 and 7.0 mg/g from cows receiving 0.0, 3.5, 7.0 and 14.0 g/d of *trans*-10, *cis*-12 CLA. Comparison of milk fat composition and synthesis revealed that reductions were most extensive for *de novo* synthesized fatty acids (short and medium chain) when cows received the two highest doses, but at the low dose (3.5 g/d) decreases in *de novo* synthesized fatty acids and preformed fatty acids were similar. Changes in milk fatty acid composition also indicated that Δ^9 -desaturase was inhibited at the two high doses of *trans*-10, *cis*-12 CLA, but relatively unaffected by the low dose. Overall, results indicate that *trans*-10, *cis*-12 CLA is a potent inhibitor of milk fat synthesis. A hyperbolic dose response curve was observed and even the low dose of *trans*-10, *cis*-12 CLA (0.016% of dietary intake) dramatically inhibited milk fat synthesis (25%).

Key Words: CLA

802 Mechanisms for conjugated linoleic acid-mediated reduction in fat deposition. Harry Mersmann^{*}, USDA/ARS Children's Nutrition Research Center, Department of Pediatrics, Baylor College of Medicine.

Potential mechanisms for the decreased fat deposition observed after oral administration of conjugated linoleic acids (CLAs) to mice, rats, hamsters, humans, and pigs will be reviewed. Most mechanisms are based on experiments with rodents or rodent-derived cells. In intact mice, there is an increased metabolic rate, but not in rats or sows. There is a decreased respiratory quotient in mice and rats, suggesting increased fat oxidation. Bovine milk-fat synthesis is decreased. Rat adipocyte size is smaller, but cell number is unchanged. In mice, there is increased adipocyte apoptosis. In 3T3-L1 preadipocytes, a clonal cell line derived from rodents, CLAs decrease proliferation. Differentiation

of these preadipocytes is diminished by CLA in two laboratories, but increased in a third. In contrast to the rodent-derived cells, CLAs did not inhibit proliferation in either porcine or human preadipocytes. In both porcine and human preadipocytes, CLAs acutely increased lipid deposition, but lipid content quickly reached a plateau. Peroxisome proliferator-activated receptor gamma (PPAR γ) and PPAR alpha, key transcription factors in adipocyte differentiation and lipid metabolism require an activating ligand; CLAs are ligands for both PPARs. The concentration of PPAR γ mRNA increases during adipocyte differentiation. In both porcine and human CLA-treated preadipocytes, the increase in PPAR γ mRNA concentration was minimal, suggesting differentiation was not markedly increased. The primary CLA isomer in ruminant tissues is cis 9, trans 11-CLA. Most synthetic CLA preparations contain a considerable amount of trans 10, cis 12-CLA, in addition to 9,11-CLA. The 10,12-CLA is responsible for the body composition changes in mice and for the decreased bovine milk-fat synthesis. The two CLA isomers equally reduced lipid deposition in porcine preadipocytes, whereas there is both evidence for a preferential effect of 10,12-CLA or no isomer distinction in human preadipocytes.

Key Words: Conjugated linoleic acid, Fat deposition, Adipocyte differentiation

803 Dietary conjugated linoleic acid (CLA) influence the lipogenic enzyme activities in adipose tissue and liver of rabbit. C. Corino¹, J. Mourot², G. Pastorelli¹, and V. Bontempo^{*3}, ¹University of Milan/Italy, ²INRA, Saint-Gilles/France, ³University of Molise, Campobasso/Italy.

A study was conducted to determine the effect of conjugated linoleic acid (CLA) synthesized from sunflower oil on lipogenic enzyme activities of adipose tissues and liver of rabbit. Thirty-six NZW rabbits, half male and half female, averaging 1.80 kg LW, allotted within weight and sex to a randomised complete experimental design, were fed ad libitum conventional pelleted diets supplemented with different CLA or sunflower oil levels: 0.5 % sunflower oil (C), 0.25 % sunflower oil and 0.25 % CLA (T1), 0.5 % CLA (T2). CLA oil contains 65 % CLA isomers (Conlino, Inc., Detroit Lakes, Minnesota 56502 USA). The rabbits were slaughtered at 2.8 kg LW. Acetyl-CoA-carboxylase (CBX) activities, expressed as nmol H-CO₃⁻ incorporated min⁻¹g⁻¹ were lower T than in C animals both in perirenal (T1= 3.14; T2= 6.34; C= 7.62; P< 0.01) and interscapular (T1= 5.40; T2= 4.98; C= 8.51; P< 0.01) adipose tissues. Glucose-6-phosphate-dehydrogenase (G6PDH), expressed as μ mol NADPH formed min⁻¹g⁻¹ resulted higher in perirenal adipose tissue of rabbits fed CLA (T1= 12.88; T2= 15.33; C= 9.3; P< 0.01). The lipogenic activities of liver was not influenced by the diet. The present study indicates that lipogenic enzyme activities are modified by dietary CLA and that are differently regulated on adipose tissues and liver of the rabbit. These results are consistent with the lower fatness of CLA fed rabbits and with the different lipogenic activities of tissues in rabbit.

Key Words: Dietary conjugated linoleic acid, Rabbit, Lipogenic enzyme

804 Performance and lipid deposition in broilers fed conjugated linoleic acid. L. Badinga*, K. T. Selberg, C. W. Comer, and R. D. Miles, University of Florida, Gainesville Florida.

With the broiler industry's major thrust in further processing, a major research challenge is to identify dietary components that reduce carcass fat deposition at economically reasonable levels of dietary protein. The objective of this study was to determine if a diet supplemented with conjugated linoleic acid (CLA) alters hepatic lipid metabolism in broiler chicks. Ninety-six 1-d-old male chicks of a commercial strain were weighed and allocated randomly to either CLA (n = 48) or control (n = 48) diets. On the basis of 63.6% CLA in the CLA source obtained from BASF Germany, the CLA mix was utilized at 7.86% of the diet to meet the assigned CLA concentration of 5.0%. The control diet was supplemented with corn oil to adjust the concentrations of total fats at 7.86% in both diets. At 3 wk, birds were weighed and feed intake measured. Twenty-four birds were randomly selected from each dietary treatment group and killed by cervical dislocation. Samples of livers and thigh muscles were collected and stored at -80C until subsequent determination of dry matter, fat and protein contents. Broilers fed CLA had smaller body weights (692.2 \pm 7.6 g < 862.2 \pm 7.6g) and grew at slower rates (30.9 \pm 0.4 g/d < 39.3 \pm 0.4 g/d) than chickens fed corn oil. Although CLA feeding significantly reduced feed intake (913.6 \pm 10.8 g < 1043.8 \pm 10.8 g), the overall feed conversion was better for

the control (feed:gain = 1.27 \pm 0.01) than the treated (F:G = 1.41 \pm 0.01) group. The total liver lipid content was 25% lower in CLA-fed birds compared with corn oil-fed birds. CLA feeding increased lean tissue (+ 1.6%) and reduced fat (- 30%) contents in thigh muscle. This resulted in significant increase (+ 45%) in lean : fat ratio in broilers fed CLA. Results provide convincing evidence that CLA supplementation increases lean tissue deposition at the expense of fat accretion in broilers and may provide a novel strategy for decreasing carcass fat and enhancing the quality of poultry meat.

Key Words: Broiler, Fat, Conjugated linoleic acid

805 Conjugated linoleic acid (CLA) in growth and development:Mechanisms involving immunity and prostanoids. Mark Cook*¹, ¹University of Wisconsin-Madison.

Mechanisms of immune-induced wasting or decrease rates of gain suggested that during the immune response, the cytokines, interleukin 1 (IL-1) and tumor necrosis factor (TNF) are released to up regulate immune and inflammatory cell activation. However, collateral damage caused by these cytokines includes decreases in rates of gain, muscle wasting, reduced feed efficiency, and anorexia, among other physiological changes. Effective approaches to reduce cytokine-induced suppression of growth have focused on removal of the immune stimulus or immune suppression. Both strategies improve animal growth, but with apparent drawbacks. Evidence that cytokines induced wasting of muscle through the stimulation of prostaglandin synthesis in skeletal muscle led us to explore an alternative method of growth stimulation in an immune challenged environment. CLA is a structural derivative of the precursor for prostanoids reported to be involved in muscle wasting and immune response down regulation. When chicks, mice, and rats were fed CLA, then immune challenged with endotoxin or TNF, significantly less depression of growth and feed intake was observed compared to linoleic acid fed animals. Even end-stage disease wasting associated with an autoimmune disease was reduced 50%. Studies showed that CLA actually enhanced a number of immune endpoints relative to controls. To determine if CLA was having an effect on prostanoid synthesis, a sensitized guinea pig (pg) model was used. A method involving the use of HPLC tandem mass spectrometry allowed us to examine antigen-induced release of 15 different lipid mediators, including prostaglandins (PG) and leukotrienes (LT), from lung, bladder, and trachea. Basal (nonstimulated) PG and LT were not affected in CLA fed pg in all tissues tested. While antigen challenge increased the release of all PG and LT in control fed gp, all PG and LT release was inhibited in all tissues from CLA fed gp. CLA regulation of antigen-induced PG and LT was not due to fatty acid changes in the phospholipids, and did not effect the antigen-induced increases of cyclooxygenase-2 (COX-2) protein in the tissue. We postulate that CLA is regulating COX-2 enzyme activity. COX-2 regulation could explain the beneficial effects observed in CLA fed animals.

Key Words: Conjugated linoleic acid , Prostanoid, Immunity

806 Dietary conjugated linoleic acid (CLA) influence the immune response in weanling piglets. V. Bontempo*¹, C. Corino², D. Sciannimanico², and S. Magni¹, ¹University of Molise, Campobasso/Italy, ²University of Milan/Italy.

The aim of this study was to determine the influence of conjugate linoleic acid (CLA) supplementation of piglets diets on some immune response parameters. Forty-two weaned piglets, 45 days old and 12.44 1.96 kg L.W., were fed diets containing different levels of CLA and sunflower oil (SFO): 0 % CLA and 1% SFO (C); 0.5 % CLA and 0.5 % SFO (T1); 1 % CLA and 0 % SFO (T2). CLA oil contained 65 % CLA isomers (Conlino, Inc., Detroit Lakes, Minnesota 56502 USA). Blood samples were withdrawn from all the piglets at 0 d and 28 d from the beginning of the experiment and analysed for serum lysozyme (Lys), total Immunoglobulin of G class (IgG), and α -1 acil glycoprotein (AGP). Lys (T2= 1.86 μ g/ml, T1= 1.77 μ g/ml and C= 1.39 μ g/ml, SEM= 0.09; P< 0.01) and IgG (T2= 2075 mg/dl, T1= 1930 mg/dl and C= 1548 mg/dl; P= 0.05) were improved by CLA dietary supplementation. No dietary effects were observed on AGP. These results support the view that CLA may influence the immune response. The lack of effects on AGP may be related to a reduction of PGE₂ production which down-regulates cytokine release and AGP release.

Key Words: Dietary conjugated linoleic acid, Weanling piglets, Immune response

807 Effects of dietary conjugated linoleic acid (CLA) on growth, carcass characteristics and meat quality of heavy pigs. C. Corino¹, V. Bontempo*², S. Magni¹, G. Pastorelli¹, R. Rossi¹, D. Sciannimanico¹, and J. Mourou³, ¹University of Milan/Italy, ²University of Molise/Italy, ³INRA, Saint-Gilles/France.

A study was conducted to determine the effect of conjugated linoleic acid (CLA) synthesized from sunflower oil on growth, carcass characteristics and meat quality of heavy pigs. Thirty-six pigs, half barrows and half females, averaging 97 kg L.W., allotted within weight and sex to a randomized complete experimental design, were fed diets supplemented with different CLA levels: 0.5% lard (C), 0.25% lard and 0.25% of CLA (T1), 0.5% of CLA (T2). CLA oil contained 65% CLA isomers (Conlinc, Inc., Detroit Lakes, Minnesota 56502 USA). The pigs were slaughtered at 172 kg L.W.. No significant differences were observed on ADG, FI, FE, dressing percentage, backfat thickness, pH and color of loin and

ham. Fatty acid composition of ham fat was significantly affected by dietary CLA. Higher levels of saturated fatty acids (C=38.5^A, T1=43.7^B and T2=41.2^B SEM=0.754), lower levels of monounsaturated fatty acids (C=46.7^A, T1=42.1^B and T2=43.7^B SEM=0.854) and higher CLA content (C=0.54^A, T1=1.01^B and T2=0.92^B SEM=0.107) were observed on fat of pigs fed CLA. These data suggest that conjugated linoleic acid have no effects on growth performances, carcass characteristics and meat quality of heavy pigs during the last fattening period. The influence of CLA on fatty acid composition of ham adipose tissue may be very important from a technological point of view for the higher content of saturated fatty acids and from a nutritional point of view for the higher CLA content.

Key Words: Dietary conjugated linoleic acid, heavy pig, carcass characteristics

ASAS/ADSA Ruminant Nutrition: Byproducts

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810 Effect of feeding a raw soybean hull-corn steep liquor pellet on the metabolism and performance of lactating dairy cows. J. M. DeFrain*¹, J. E. Shirley¹, E. C. Titgemeyer¹, A. F. Park¹, and R. T. Ethington², ¹Kansas State University, Manhattan, ²Minnesota Corn Processors, Inc.

Eighteen multiparous Holstein cows (148 ± 35 DIM) averaging 41.5 kg/d ECM were used in six 3 × 3 Latin squares with 28-d periods to evaluate the effect of a raw soybean hull-corn steep liquor pellet (SHSL) on the performance of lactating dairy cows. Cows were blocked by pretreatment BW and ECM and assigned to control (C), SHSL (20% of diet DM), or pelleted raw soybean hulls (SH, 15% of diet DM). C contained 30% alfalfa hay, 15% corn silage, 34% corn, 9.3% whole cottonseed, 5% soybean meal (SBM), 2% fish meal, 0.5% blood meal, 1% wet molasses, and 3.2% vitamin/minerals. SHSL replaced 6.2% alfalfa hay, 3.7% corn silage, 6.6% corn, 3.3% SBM, and 1.7% expeller SBM replaced solvent SBM to maintain similar dietary RUP levels. SH replaced 6.2% alfalfa hay, 3.7% corn silage, and 5.1% corn. Diet CP % and energy density (Mcal/kg NEL) were 16.6 and 1.78, 16.3 and 1.73, 17.1 and 1.71 for C, SHSL, and SH, respectively. DMI of cows fed SHSL were similar to C and SH, but cows fed SH consumed more (P < 0.05) DM than cows fed C. Milk and ECM were similar for cows fed SHSL and SH, but lower (P < 0.05) for those fed C. Production efficiencies (ECM/DMI) were not affected by diet, but CP output in milk/CP intake was highest (P < 0.05) for cows fed SHSL and similar between those fed SH and C. Milk fat percent and SCC were similar for cows fed SHSL and SH but higher (P < 0.05) for those fed C. Milk fat yield and milk protein percent were not affected by diet, but feeding SHSL and SH increased (P < 0.05) milk protein yield, MUN, and PUN. BW, BCS, milk N distribution, and glucose, NEFA, and triacylglycerol in plasma were not influenced by diets. Cows fed SHSL and SH had higher (P < 0.05) total alpha-amino N in plasma, but individual amino acids in plasma were similar. SHSL can replace a portion of the forage, grain, and SBM in diets for lactating dairy cows without decreasing production.

Key Words: Soybean hulls, Steep liquor, By-product

811 The impact of feeding a raw soybean hull-corn steep liquor pellet on induced subacute ruminal acidosis in lactating cows. J. M. DeFrain*¹, J. E. Shirley¹, E. C. Titgemeyer¹, A. F. Park¹, and R. T. Ethington², ¹Kansas State University, Manhattan, ²Minnesota Corn Processors, Inc.

We used four ruminally cannulated, multiparous Holstein cows (690 kg; 21 kg/d milk) in a 2-period cross-over design to determine the impact of feeding a raw soybean hull-corn steep liquor pellet (SHSL) on induced subacute ruminal acidosis (SARA) in lactating cows. Cows were fed control (30% alfalfa hay, 15% corn silage, 34% corn, 9% whole cottonseed, 5% soybean meal (SBM), 2% fish meal, 0.5% blood meal, 1% wet molasses, and 3.5% vitamin/minerals) or SHSL (20% of diet DM) diets as TMR. SHSL replaced 6.2% alfalfa hay, 3.7% corn silage, 6.6% corn,

3.3% SBM, and 1.7% expeller SBM replaced solvent SBM to maintain similar dietary RUP levels. Periods were 15 d (10 d adaptation, 2 d for pre-challenge measures, and 3 d of SARA challenge). During d 7 to 12 cows were fed once daily at a common DMI (3.2% of BW) dictated by the cow consuming the least. Cows were fasted 12 h prior to the first SARA challenge. For each SARA challenge (d 13, 14, and 15), cows were offered 75% of their daily diet at 0600 h. The remaining 25% of diet DM was replaced by ground corn which was mixed with orts remaining 2 h after feeding and placed into the rumen at that time. Rumen fluid was collected before and 3, 6, 9, and 12 h after feeding during d 11 to 15. Ruminal pH declined linearly with time after feeding (P < 0.01), and this decrease was greater during the SARA challenges (P < 0.01). Ruminal lactate was essentially 0 on d 11 and 12 and increased linearly (P < 0.05) with repeated SARA challenges. Concentrations of total ruminal VFA increased linearly (P < 0.01) after feeding, and increases were greater on challenge days than on d 11 and 12. There were no differences due to SHSL inclusion. These data suggest the model used to induce SARA was successful and the partial replacement of alfalfa, corn silage, corn, and SBM by SHSL did not influence the response to SARA challenges.

Key Words: Acidosis, Soyhulls, Steep liquor

812 Relative nutritive value of dried versus wet brewers' grain for dairy cows. T. R. Dhiman¹, M. S. Zaman*¹, I. S. MacQueen¹, and H. D. Radloff², ¹Department of Animal, Dairy and Veterinary Sciences, Utah State University, Logan, UT 84322-4815, ²A-L Gilbert Company, Oakdale, CA.

Twenty-four lactating cows (699 41.1 kg BW; 56 25.3 days in milk) were used to study the nutritive value of dried and wet brewers' grain for dairy cows. Twenty intact and four cows fitted with a rumen cannula were blocked according to milk yield and randomly assigned to two treatments. Each treatment had ten intact and two cows fitted with a rumen cannula. Cows were fed a total mixed ration (TMR) twice a day containing either dried or wet brewers' grain at 15% of the dietary DM. The diet contained 43% forage and 53% concentrate. The experimental design was a switch back with two periods. Each period was 5 wk. First 2 wk in each period were considered as an adaptation to the diets and data from the last 3 wk were used for treatment comparisons. Total duration of the experiment was 10 wk. Once a week milk samples were analyzed for chemical compositions. Ruminal pH, ammonia-N and VFA concentrations were measured in the rumen-cannulated cows. Dried and wet brewers' diets contained 68.0 and 66.5% DM; 16.9 and 16.9% CP; 40.4 and 42.0% NDF; 24.4 and 24.5% ADF, respectively. The feed DM intake were 25.4 and 24.8 kg/d and 3.5% fat corrected milk (FCM) yield 39.8 and 40.1 kg/d for cows fed dried and wet brewers' grain, respectively. Cows fed dried or wet brewers' grain had similar (P > 0.05) feed intake, milk yield, energy intake, milk composition, feed efficiency (FCM/DMI), ruminal pH, ruminal ammonia-N and ruminal total VFA concentrations. The results suggest that the performance of cows fed either dried or wet brewers' grain at 15% of dietary DM was similar when the TMR had the same amount of DM. The storage of wet brewers' grain for a lengthy time is always a concern especially in summer. However, based on milk yield response and drying cost, it might be beneficial to feed wet brewers' grain in areas close to the brewery.

Key Words: Cow, Brewer's grain, Milk

813 Effects of mechanical treatment of high-moisture rye and wheat grains on ruminal fermentation and nutrient digestibilities in steers. K.-H. Sdekum¹, A. Schrder¹, C. Idler², T. Hoffmann², M. Klein¹, and C. Frll², ¹University of Kiel, Germany, ²ATB, Potsdam, Germany.

In maritime climates cereal grains are often harvested at dry matter (DM) concentrations below 86% that prevent direct storage as food or feed ingredient. Airtight storage without additives of high-moisture, rolled grain containing > 80 and < 86% DM has emerged as a low-cost alternative to additive-supported storage. We studied effects on nutrient digestibilities and ruminal fermentation in steers of mechanical treatments applied to wheat and rye grains after storage. Wheat and rye grains were harvested at approximately 82% DM, rolled and stored airtight in a bunker silo. Each grain type was fed in three different physical forms to six mature, ruminally cannulated steers: Rolled prior to storage (ROLLED), ROLLED plus ground prior to feeding in a mill with a 6-mm sieve, and ROLLED plus ground prior to feeding in a mill with a 3-mm sieve. Steers were fed at 1.3 times maintenance energy requirements on forage:concentrate diets (30:70, DM basis) containing > 45% starch twice daily at 0700 and 1900 h. Wheat and rye were fed in two separate trials each according to a replicated 3 × 3 Latin square design. The same 30:70 forage:concentrate diet containing a dry-ground wheat-and-rye (50:50) mix (88% DM) was fed to the same group of six steers in a separate trial. Across all trials, organic matter (OM) and starch digestibilities were not affected ($P > 0.10$) by grain type or mechanical treatment. Average whole-tract OM and starch digestibilities were 80 and 99%, respectively. As a general observation, ruminal pH values were above 6.0 for almost all hours during the 24-h cycle. On an average, ruminal pH was 0.2 pH units higher with the wheat than with the rye diets, indicating a more rapid fermentation of rye. Grain source affected ruminal pH values more than did mechanical treatment. Rolling high-moisture wheat and rye grains prior to airtight storage appears sufficient to ensure complete starch digestion while maintaining a favorable ruminal environment.

Key Words: Cereal grain, Digestibility, Ruminal fermentation

814 Dehydrated bermudagrass pellets (DBP) produced with swine lagoon effluent as a substitute for cottonseed hulls (CSH) in diets for backgrounding steers. M.H. Poore*, B.A. Hopkins, and G.A. Benson, *North Carolina State University, Raleigh.*

Production of DBP might be an option for removing high quality forage from swine sprayfields. This trial evaluated two batches of DBP (2 and 4 wk maturities) for growing cattle. Respective nutrient concentrations for the 2 and 4 wk were; CP, 19.7 and 16.5; NDF, 66.3 and 66.9; ADF, 32.6 and 35.7; and nitrate ion, 1.20 and 0.89%. Fifty-six steers (initial wt 294 kg) were individually fed for 84-d. The control diet was (DM basis) 25% corn silage (CS), 25% CSH, 20% corn, 18.5% soybean hulls (SH) and 10.7% soybean meal (SBM). Each source of DBP was substituted for 1/3, 2/3 or all the CSH to make 7 diets (control, 1/3 2 wk, 2/3 2 wk, 3/3 2 wk, 1/3 4 wk, 2/3 4wk and 3/3 4 wk = diet 1, 2, 3, 4, 5, 6 and 7, respectively). SH and SBM were adjusted to maintain CP at 13% and NDF from roughage at 43%. Substituting 2 wk DBP for CSH resulted in a linear (L, $P < .01$) and quadratic (Q, $P < .03$) effect on DMI while 4 wk had no influence (10.3, 11.0, 10.1, 8.9, 9.9, 10.1 and 9.8 kg/d for diet 1, 2, 3, 4, 5, 6 and 7, respectively). Average daily gain response to 2 wk was L ($P < .04$) while the response to 4 wk was both L ($P < .08$) and Q ($P < .05$); 1.91, 1.86, 1.74, 1.72, 1.65, 1.68 and 1.71 kg/d for diet 1, 2, 3, 4, 5, 6, and 7, respectively). Feed efficiency showed a Q response to 2 wk ($P < .05$) while the response to 4 wk tended ($P = .16$) to be Q (.186, .171, .173, .196, .167, .168 and .174 for diet 1, 2, 3, 4, 5, 6 and 7, respectively). An economic analysis was conducted assuming a value of .110, .138, .22, .039 and .088 \$/kg for CSH, corn, SBM, CS and SH, respectively, and an initial and final cattle value of 1.76 and 1.56 \$/kg shrunk wt. Assuming no value for the DBP, return over feed cost response was L to 2 wk ($P < .01$) while for 4 wk the response was both L ($P < .01$) and Q ($P < .03$), showing the DPB had value. Calculated value of DBP was .058, .193, .140, -.063, .027 and .113 \$/kg in diet 2, 3, 4, 5, 6 and 7, respectively. This study showed that DPB has potential in this type of diet, especially at the higher inclusion levels.

Key Words: Bermudagrass, Cottonseed Hulls, Cattle

815 Effects of replacing dietary high moisture corn with dried molasses on production of dairy cows. G. A. Broderick* and W. J. Smith, *U.S. Dairy Forage Research Center, Madison, WI.*

Eight primiparous and 40 multiparous (8 with rumen cannulae) Holsteins were blocked by parity and DIM, randomly assigned to 4 blocks of 12 and fed TMR containing (DM basis): 40% alfalfa silage, 20% corn silage, 8% soybean meal, 2% added fat, 1% minerals and vitamins, and 18% CP. Dietary sugar was varied by replacing rolled high moisture shelled corn (HMSC) with dried molasses. The 4 diets were: 0% molasses, 29% HMSC; 4% molasses, 25% HMSC; 8% molasses, 21% HMSC; or 12% molasses, 17% HMSC. Cows were fed the 0% molasses diet for a 2-wk covariate period, experimental diets for 8 wk, then the 0% molasses diet for another 2 wk covariate. Milk yield and DMI were measured daily. Yield of milk components was determined one day in both covariates and every 2-wk in the 8-wk trial. Rumen sampling was in trial wk 4 and 8. The statistical model included block and covariate average. LS means are reported below. There was a linear increase in DMI and linear decreases in milk/DMI and milk N/NI with increasing dietary sugar. There were quadratic responses in yield of FCM and fat, and rumen NH₃, with increasing sugar; FCM and fat yield maxima and rumen NH₃ minimum occurred at about 6% molasses. Several cubic responses were noted that were related to similar milk and protein yields at 0 and 8% molasses. Replacing readily fermented starch with dietary sugar primarily increased fat yield.

Item	Molasses, %	0	4	8	12	SE	L ¹	Q ¹	C ¹
HMSC, %		29	25	21	17				
DMI, kg/d		25.1	25.8	26.2	26.0	0.3	0.04	0.16	0.83
Milk, kg/d		38.0	37.5	38.9	36.7	0.6	0.34	0.16	0.04
Milk/DMI		1.51	1.46	1.48	1.43	0.02	0.03	0.99	0.17
Milk N/NI		0.255	0.244	0.254	0.231	0.006	0.02	0.29	0.03
3.5% FCM, kg/d		41.4	42.0	43.4	39.5	1.0	0.33	0.04	0.20
Fat, %		4.07	4.26	4.11	4.06	0.10	0.65	0.24	0.33
Fat, kg/d		1.54	1.59	1.63	1.47	0.04	0.34	0.03	0.36
Protein, %		3.12	3.09	3.11	3.04	0.04	0.29	0.61	0.45
Protein, kg/d		1.19	1.14	1.23	1.09	0.03	0.10	0.11	0.01
True protein, kg/d		1.14	1.09	1.17	1.05	0.03	0.11	0.19	0.02
SNF, kg/d		3.38	3.30	3.49	3.18	0.08	0.25	0.18	0.05
Rumen NH ₃ , mM		11.3	9.1	10.7	10.7	0.5	0.86	0.05	0.03

¹Probability of linear (L), quadratic (Q) and cubic (C) effects.

Key Words: Molasses, High moisture corn, Milk yield

816 Effects of pea silage as a forage source in high concentrate diets on ruminal metabolism and total tract nutrient utilization of steers. S. G. Wielgosz*, A. F. Mustafa, D. A. Christensen, and J. J. McKinnon, *University of Saskatchewan, Saskatoon, Saskatchewan, Canada.*

A study was conducted to determine the feeding value of pea silage (PS) relative to alfalfa silage (AS) and barley silage (BS) in high concentrate diets of beef steers on ruminal fermentation and total tract nutrient utilization. Nine steers, six of which were equipped with ruminal cannulae were used in a randomized complete block design. Finishing diets were formulated to contain 90% barley-based concentrate and 10% forage, which included either PS, AS or BS. All diets were formulated to be isonitrogenous. Steers fed PS and AS as forage sources had a similar dry matter (DM) intake (average 11.5 kg), which was greater ($P < 0.05$) than that of steers fed BS (9.5 kg). Total tract digestibility of DM and gross energy was higher ($P < 0.05$) for steers fed PS (80.9 and 80.0%, respectively) than for those fed AS (78.6 and 77.9%, respectively) or BS (77.6 and 77.0%, respectively). Forage source had no effect on total tract digestibility of crude protein, neutral detergent and acid detergent fiber. Ruminal pH was higher ($P < 0.05$) for steers fed PS relative to steers fed AS or BS while ruminal ammonia nitrogen concentration was higher ($P < 0.05$) for steers fed PS and BS compared with those fed AS. Total ruminal volatile fatty acid concentration was not affected by forage source. However, molar proportions of acetate and butyrate were higher ($P < 0.05$) while that of propionate was lower ($P < 0.05$) for

steers fed PS and BS relative to steers fed AS. It was concluded that the inclusion of PS as a forage source in finishing diets of beef steers can increase feed intake and improve nutrient utilization when compared with AS and BS.

Key Words: Pea Silage, Nutrient utilization, Ruminant metabolism

817 Prediction of the in vivo digestibility of grass silage from gas production kinetics. P. Huhtanen^{*1}, M. Ots², S. Ahvenjrvi¹, and M. Rinne¹, ¹*MTT Agrifood Research Finland*, ²*Estonian Agricultural University*.

The objective of this study was to compare in vivo OM (OMD) and NDF digestibility (NDFD) determined in sheep and those predicted from in vitro gas production data using a rumen model. Fifteen silages were made from 1st cut timothy-meadow fescue sward at different stages of maturity over three years. The rate and extent of gas production was measured using computerized gas monitoring system with pressure transducers and electric valves to release overpressure. Triplicate incubations of 72 h were made using 500 mg samples of the whole forage and NDF residue. Kinetic parameters were estimated using two-pool Gompertz model. Potential NDF digestibility (pNDFD) was determined by 12 d in situ incubation in nylon bags. Rumen digestibility of digestible NDF (RDpNDFD) was predicted using a two compartmental rumen model assuming a 50 h retention time in the fermentation compartments. In vivo NDFD was predicted as pNDFD × RDpNDFD. In vivo OMD was estimated from the predicted NDFD and applying the Lucas equation for cell solubles (OM-NDF). Total gas production (TGP) was not correlated ($R^2=0.001$) with in vivo OMD (range 61.3-83.2%). However, there was a good relationship between TGP and in vivo NDFD ($R^2=0.90$), and between TGP and pNDFD ($R^2=0.94$). Based on the Lucas equation, the true digestibility of cell solubles was 100% and metabolic faecal OM output was 96 g per kg DMI. A combination of predicted NDFD and parameters from the Lucas equation for cell solubles was a good predictor of in vivo OMD ($Y = -0.74 + 1.003X$, $R^2=0.99$; se.est 0.85). This approach was better than using kinetic parameters estimated for the whole forage ($Y = -5.50 + 1.092X$, $R^2=0.99$; se.est 1.41). Gas production method is a useful tool to estimate digestion kinetic parameters to be used in rumen models to predict in vivo NDFD and OMD of silages. The results suggest that using NDF rather than whole forage in incubations predicts feeding value of forages more accurately.

Key Words: Forage Digestibility, Gas Production, Modelling

818 Comparison of Novartis corn silage hybrids for yield, nutrient traits, and lactational performance by high producing dairy cows. E. D. Thomas¹, C. S. Ballard^{*1}, P. Mandebvu¹, C. J. Sniffen¹, M. P. Carter¹, and J. Beck², ¹*W. H. Miner Agricultural Research Institute, Chazy, NY*, ²*Novartis Seeds, Inc., Golden Valley, MN*.

Novartis N29-F1 (N29-F1), a dual-purpose 90-d relative maturity corn hybrid, and Novartis NX3018 (NX3018), a 90-d relative maturity leafy corn silage hybrid planted in replicated 15.2 × 351-m plots were compared. Parameters measured from N29-F1 and NX3018, respectively, prior to ensiling were DM yield (t/ha): 14.7, 13.7 (SE=0.69; $P=0.407$); 30-h in vitro true DM disappearance (IVTDMD) (%): 77.8, 79.9 (SE=1.04; $P=0.228$); 30-h IVNDFD (%): 49.2, 53.9 (SE=1.13; $P=0.044$); starch (%DM): 40.6, 37.0 (SE=1.34; $P=0.202$); and NDF (%DM): 39.6, 41.6 (SE=1.33; $P=0.405$). Plant fractions expressed as a proportion of whole plant on DM basis for N29-F1 and NX3018, respectively, were grain: 53.4, 49.8 (SE=0.88; $P=0.005$); leaves: 10.2, 12.3 (SE=0.21; $P=0.0001$); and stalks: 22.5, 25.1 (SE=0.81; $P=0.026$). The IVTDMD for plant fractions on DM basis for N29-F1 and NX3018, respectively, were grain: 97.6, 98.9 (SE=0.14; $P=0.022$); leaves: 71.6, 77.4 (SE=0.85; $P=0.041$); and stalks: 42.7, 53.4 (SE=2.68; $P=0.107$). The lactation study was conducted as a crossover design with two 28-d periods. Nutrient parameters of N29-F1 and NX3018 corn silages, respectively, used in the lactation trial were NDF (%DM): 40.6, 40.7; starch (%DM): 35.6, 34.6; IVTDMD (%): 77.0, 81.1; and IVNDFD (%): 45.7, 55.3. Thirty-eight mid-lactation multiparous Holstein cows (7823.0 DIM; 47.28.87 kg/cow average daily milk yield) were blocked and assigned randomly to one of two TMR containing on DM basis approximately 26% N29-F1 or NX3018 corn silage. The TMR which were formulated using the CPM Dairy[®] nutrition model, had a forage to concentrate ratio of 44 to 56%, and contained 36.5% NDF, and 17.8% CP

on DM basis. Cows were group-fed TMR for ad libitum intake. Measurements collected from the cows fed N29-F1 and NX3018 corn silage-based TMR, respectively, were milk yield (kg/d): 45.1, 46.6, (SE=0.45; $P=0.024$); 3.5% FCM yield (kg/d): 47.2, 48.9 (SE=0.61; $P=0.059$); milk fat (%): 3.90, 3.89 (SE=0.078; $P=0.973$); milk CP (%): 3.08, 3.06 (SE=0.012; $P=0.222$); SCC (×1000/ml): 143, 215 (SE=33.9; $P=0.991$); and body condition score: 3.09, 3.12 (SE=0.022; $P=0.332$). The average daily DMI across treatments was about 28.2 kg/cow. In conclusion, NX3018 was more leafy and more digestible in vitro compared to N29-F1, and cows that were fed NX3018 produced more milk than cows fed N29-F1.

Key Words: corn silage hybrids, DM yield and digestibility, dairy cow and milk yield

819 Crop processing and chop length effects in brown midrib corn silage on dry matter intake and lactation performance by dairy cows. E. C. Schwab^{*} and R. D. Shaver, *University of Wisconsin, Madison, WI*.

Brown midrib-3 corn silage was harvested at three-quarter milking stage of maturity using a crop-processing harvester with rolls set at 2 mm clearance (PR) or unprocessed (UP). Theoretical lengths of cut (TLC) were 13 and 19 mm for unprocessed corn silage treatments (13UP and 19UP), and 19 and 32 mm for the processed corn silage treatments (19PR and 32PR). Corn silage treatments were stored in four separate silo bags. Dry matter, NDF, and ADF concentrations (DM basis) of the corn silage treatments averaged 39%, 37%, and 23%, respectively. Mean particle size of 13UP, 19UP, 19PR, and 32PR corn silage treatments were 9.7, 12.0, 9.7, and 10.8 mm, respectively. Twenty-four multiparous Holstein cows averaging 102±17 DIM at trial initiation were used in a replicated 4 × 4 Latin square design with 28-d periods. Orthogonal contrasts were used to evaluate TLC (13UP vs. 19UP and 19PR vs. 32PR) and crop processing (19UP vs. 19PR) effects. Diets formulated to contain 18% CP were fed twice daily as a TMR comprised of 40% respective treatment corn silage, 20% alfalfa silage, and 40% concentrate (DM basis). The DM, NDF and ADF concentrations (DM basis) of the four treatment diets averaged 56%, 26%, and 16%, respectively. Increasing TLC reduced ($P < 0.05$) DMI in unprocessed (25.5 kg/d for 19UP vs. 26.6 kg/d for 13UP) and processed (25.1 kg/d for 32PR vs. 25.9 kg/d for 19PR) corn silage treatments. Chop length did not affect milk and 3.5% FCM yields or milk protein percentage and yield. Crop processing did not affect DMI or milk yield, but there was a trend ($P < 0.10$) for reduced 3.5% FCM in the 19 mm TLC processed corn silage treatment (40.6 kg/d for 19PR vs. 41.8 kg/d for 19UP). Milk fat percentage (3.11 vs. 3.35%) and yield (1.35 vs. 1.43 kg/d) were reduced ($P < 0.05$) by crop processing of the 19 mm TLC corn silage treatment. In this trial with brown midrib corn silage fed to mid lactation dairy cows, there were no benefits from crop processing or increasing TLC on DMI or lactation performance.

Key Words: crop processing, chop length, corn silage

820 Neutral Detergent Fiber Concentration in Corn Silage Influences Dry Matter Intake, Diet Digestibility, and Performance of Growing British and Holstein Steers. K.E. Tjardes^{*}, D.D. Buskirk, M.S. Allen, and R.J. Tempelman, *Michigan State University, East Lansing, MI*.

Twelve British (237 ± 13 kg) and 12 Holstein (235 ± 15 kg) steers were used to determine if a corn silage-based diet high in NDF depresses DMI as steers increase in body weight and to determine if a diet high in NDF has the same influence on British and Holstein steers. Steers were randomly assigned to individual slatted-floor pens and used in a crossover design consisting of six 14-d periods. Experimental diets contained corn silage from a normal hybrid (low-fiber; LF) and its male-sterile counterpart (high-fiber; HF). The LF and HF diets contained 33.8 and 50.8% NDF. The HF diet reduced ADG (0.99 vs 1.15 kg/d; $P < 0.01$) and consistently decreased steer DMI during each period ($P < 0.01$). Holsteins consumed 14.4% more DM, and gained 14.3% faster than British steers ($P < 0.01$). There was a fiber level × breed interaction ($P < 0.10$) for efficiency of gain. British steers receiving HF were more efficient than British steers consuming LF (0.188 vs 0.173); however, Holsteins consuming LF were more efficient than those receiving HF (0.186 vs 0.174). The HF treatment increased total-tract digestibility of NDF and ADF (9.4 and 8.4%; $P < 0.01$), but reduced digestibility of DM and GE (4.6

and 4.5%; $P < 0.01$), and decreased DM intake 20.5% ($P < 0.01$). Holsteins had similar digestibility of DM and GE, but had greater DE intake ($P < 0.01$) when compared to British steers. Change in DM digestibility was negatively correlated to change in DMI ($r = -0.48$; $P < 0.01$) for LF vs HF within British steers, but not Holsteins ($P = 0.42$). There were fiber level \times breed interactions for digestibility of NDF and ADF ($P < 0.10$). When comparing Holstein to British steers, digestibility of

NDF and ADF was 4.1 and 3.4% lower for LF, but was only 1.1 and 0.6% lower for HF, respectively. Results from this trial suggest that high NDF corn silage diets may reduce intake of both British and Holstein steers by physical fill, and this reduction in DMI continues as steers increase in body weight from 240 to 330 kg.

Key Words: Fiber Level, Physical Fill, Male-sterile Corn

ASAS/ADSA Ruminant Nutrition: Fiber

821 Measuring neutral detergent fiber in feeds and forages. D. R. Mertens^{*1} and D. Sauvant², ¹*US Dairy Forage Research Center, Madison, WI*, ²*INRA-Institut National Agronomique, Paris-Grignon*.

Neutral detergent fiber (NDF) is an important characteristic for measuring the nutritive value of feeds and forages. For ruminants, fiber can be defined as the indigestible or slowly-digesting components of feeds that occupy space in the gastrointestinal tract, which indicates that fiber can be determined only by the animal. Measurement of fiber is a compromise between the theoretical concept and the utility of using chemical methods to isolate and measure fractions that closely resemble it. The method used to isolate it, in effect, defines a specific type of fiber; therefore, it follows that fiber methods must be followed exactly to obtain results that are valid and reproducible. The NDF method was originally designed to measure fiber in forages and has acquired the reputation of being variable and difficult to use with other feeds. However, the greatest source of variability in NDF is related to various modifications and alternative procedures. In addition, laboratories sometimes modify fiber methods for convenience or speed without understanding how these changes affect results. Many factors can affect the determination of fiber and it is important to understand the conditions and steps in fiber methods that must be followed closely to obtain accurate results. Among these are: subsampling, drying, grinding and amount of the sample, standardization of reagents, pretreatment with acetone, removal of starch and nitrogen contamination, timing and temperature of refluxing, soaking, washing and transferring of fibrous residues, type of filtration vessel, method of weighing, and correction for ash or protein. Use of heat-stable amylase to remove starches and sulfite or proteases to remove nitrogen have significant impact on NDF determinations. They also affect soluble carbohydrate estimates that are calculated by difference. The amylase-treated NDF (aNDF) method, which uses both amylase and sulfite, solves most of the problems associated with measuring NDF, and with appropriate modifications can be used to measure fiber in protein, starch, pectin and fat-containing materials.

Key Words: Fiber methods, NDF, Feed evaluation

822 Fiber requirements for finishing beef cattle - a commercial feedlot perspective. R.S. Swingle*, M.E. Branine, and K.K. Karr, *Cactus Feeders and Cactus Research, Ltd., Amarillo, TX*.

It is generally accepted that dietary fiber is necessary in diets for finishing beef cattle to maximize net energy intake above maintenance and to lessen the risk of metabolic disorders. Fiber functions primarily to assist in maintaining ruminal pH above a critical threshold. Therefore, fiber requirements must be considered in the context of the physical nature of the fiber, fermentability of diet organic matter and meal size and frequency. Finishing diets typically contain only minimal fiber (5 to 15% roughage on a DM basis) and a high concentration of readily fermentable organic matter, which magnifies the importance of feeding management for influencing feed intake patterns to minimize daily fluctuations in ruminal pH. Concepts used to optimize NDF in diets for lactating dairy cows may be useful for refining fiber requirements for feedlot cattle but have not been tested extensively. Progress in this area is hindered by a lack of consensus on appropriate response criteria for assessing fiber status and a paucity of fiber equivalency values for diet formulation. Effects of fiber source, fiber level or organic matter fermentability treatments on rate of gain might be a practical indicator of fiber adequacy under research conditions due to the direct relationship between rate of gain and net energy intake. Because particle size distribution is a major determinant of fiber effectiveness, establishing the critical particle length for fiber in finishing diets and a more complete catalogue of particle size distributions and variation in common diet ingredients would be useful. Economic and operational realities continually provide

incentives to minimize fiber in finishing diets; the challenge is to develop procedures that will more precisely determine the minimum level that is compatible with production and economic objectives of specific feeding operations.

Key Words: Feedlot Cattle, Fiber Requirements, Effective Fiber

823 Digestible fiber from forages for lactating cows. M. S. Allen*, M. Oba, and J. A. Voelker, *Michigan State University, East Lansing*.

Coarse dietary fiber benefits lactating cows through selective retention of digestible organic matter in the rumen, more consistent supply of absorbed fuels within a day, and moderation of ruminal pH. However, energy density of neutral-detergent fiber (NDF) is lower and forage NDF is more filling than other dietary components; diets with high forage NDF can reduce energy intake by mechanisms related to ruminal distention. Forage NDF that is highly digestible is less filling and allows greater energy intake. Distention becomes a dominant mechanism limiting feed intake as milk yield increases, thus response to increased in vitro NDF digestibility is positively related to milk yield of cows. Maximum extent of digestion of forage NDF is negatively related to NDF lignification and is determined by environmental conditions during growth, plant genetics, and maturity at harvest. Digestibility of NDF in vivo is further determined by ruminal retention time and rate of digestion. Rate of NDF digestion is limited by low ruminal pH, high starch diets, and availability of nutrients for microbial growth. Although digestibility of forage NDF measured in vitro or in situ is positively related to feed intake and milk yield within a forage family, grass NDF digests and passes from the rumen more slowly than legume NDF and is therefore more filling despite its generally higher digestibility. Digestibility of NDF measured in vitro or in situ is negatively related to the filling effects of NDF, but is not necessarily an index of energy content. Forages with higher in vitro NDF digestibility allow greater DMI for cows with fed intake limited by physical fill, but reduced ruminal retention time decreases differences in NDF digestibility in vivo. Although DMI and NDF digestibility are positively related, DMI by cows is less limited by distension in the gastrointestinal tract as NDF digestibility increases, and therefore diminishing returns are expected for DMI. This presentation will discuss factors affecting NDF digestibility of forages, measurement and prediction of NDF digestibility, and benefits of highly digestible forage NDF.

Key Words: NDF digestibility, lactating cows, forage

824 Empirical modeling of ruminal pH from dietary NDF and mean particle size. D. Sauvant^{*1} and D. Mertens², ¹*Institut National Agronomique Paris-Grignon - INRA*, ²*US Dairy Forage Research Center*.

Accurate prediction of rumen pH is a challenge in ruminant nutrition. Numerous experiments have studied some aspects of the effects of the chemical and physical characteristics of fiber on ruminal pH. The results of these studies were combined for a meta-analysis of fiber-related factors affecting ruminal pH. Two databases were compiled, the first one consisted of trials where NDF content was the experimental factor and its mean value was $< 50\%$ DM (35 publications, 46 experiments, 120 treatments; NDF = $32.2 \pm 6.2\%$ DM (mean standard deviation or sd). The second database consisted of data from experiments where dietary mean particle size (MPS) was the primary experimental factor (12 publications, 19 experiments, 51 treatments; MPS = 2.59 ± 1.48 mm). Ruminal pH were similar between the two bases (pH = 6.16 ± 0.30 , $n = 120$ and pH = 6.25 ± 0.32 , $n = 51$). A GLM model of variance-covariance was used for statistical analysis that allowed relationships

across (global) and within (local) experiments to be investigated. Variance analysis was between experiments, and covariates were either NDF content or MPS. The interactions between experiments (E) and covariates were also tested (either E*NDF or E*MPS). For the NDF database, the interactions between experiments and NDF were significant ($pH = 5.25 + 0.028 \text{ NDF} + E*\text{NDF}$, $n = 120$, $R^2 = 0.98$, $rsd = 0.09$). The response of pH to dietary NDF was greater when the experimental mean ruminal pH was low than when experimental pH was high. For instance, $dpH/dNDF = 0.037$ when mean pH = 5.8 and = 0.018 when mean pH = 6.5. There were also significant interactions between experiments and MPS ($pH = 5.67 + 0.24 \text{ MPS} + E*\text{MPS}$, $n = 51$, $R^2 = 0.98$, $rsd = 0.07$). The pH response to MPS variation was more pronounced in experiments when mean pH was low. For instance, $dpH/dMPS = 1.14$ when mean pH = 5.8 and = 0.21 when mean pH = 6.5. These analyses indicate that both NDF and MPS influence ruminal pH and that the sensitivity of rumen pH to these two factors is greater when rumen pH is less than 6.0.

Key Words: Rumen, pH, Fiber

825 Effect of different particle size distribution of oat silage on feeding behavior and productive performance of dairy cattle. C. Leonardi*, L.E. Armentano, and K.J. Shinnors, University of Wisconsin-Madison.

Twenty lactating Holstein cows (5 primiparous and 15 multiparous) were used in an incomplete Latin Square, with five treatments and three periods of 21 days each. Diets contained 25% corn silage, 25% oat silage and 50% grain mix (DM basis). The five treatments tested in the experiment were: Long Oat Silage (LOS), Medium Oat Silage (MOS), Fine from Long Oat Silage (FLOS), Fine from Medium Oat Silage (FMOS), and Half LOS plus half FLOS (LFLOS). LOS and MOS silages were obtained directly in the field (2 vs. 8 knives on the harvester). FLOS and FMOS were obtained by chopping LOS and MOS just prior to feeding. The mean particle size (MPS) of the diets was 4.35, 4.46, 5.19, 5.39, and 6.68 mm for FMOS, FLOS, MOS, LFLOS, and LOS respectively. MOS was designed to provide similar MPS of LFLOS, but narrower particle size distribution. Sorting is expressed as (MPS of the intake/ MPS of the diet) x100. Treatments were tested for linear and quadratic response, utilizing the MPS of the intake to calculate the contrast coefficients. No quadratic response was observed. The primary effect was a linear decrease of DMI, milk yield, and milk protein yield with longer oat silage. Feeding longer particle size increased time spent eating, ruminating and chewing per kg of DMI. Increasing particle size increased sorting. LFLOS was similar to MOS with the possible exception of eating time.

	Trt ¹					SEM	L ²	Contrast	
	FMOS	FLOS	MOS	LFLOS	LOS			1vs2	3vs4
	1	2	3	4	5				
DMI, kg/d	22.1	22.0	21.7	21.1	20.4	.5	<.01	.92	.30
Milk yield, kg/d	39.4	40.3	39.0	39.1	38.2	.9	<.01	.20	.87
Protein, g/d	1075	1095	1059	1060	1026	26	<.01	.36	.98
Fat, g/d	1305	1340	1312	1257	1283	41	.18	.39	.15
Eating, min/kd									
DMI	10.5	11.1	11.4	12.8	13.4	.7	<.01	.53	.11
Ruminating, min/kg									
DMI	25.1	24.5	25.6	26.2	28.0	.9	<.01	.51	.46
Chewing, min/kg									
DMI	35.4	35.7	37.1	39.3	41.5	1.2	<.01	.81	.13
Intake MPS/diet									
MPS, %	99.4	98.4	97.3	96.1	93.5	var ³	<.01	<.01	.54

¹T= Treatments. ²L= Linear; ³var=variance. Treatments presented unequal variance. In the statistical analysis the variance was grouped for

FLOS and FMOS, and for MOS, FLFOS, and LOS. The SEM was .4 for FLOS and FMOS, and 1.2 for MOS, FLFOS, and LOS.

Key Words: Oat silage, Particle size

826 Partitioning in vitro digestibility of corn silages of different particle sizes. D.R. Mertens*¹ and G. Ferreira², ¹US Dairy Forage Research Center, Madison, WI, ²Universidad Catolica Argentina, Buenos Aires.

In vitro apparent (IVDMD) and true DM disappearances (IVDMT - using neutral detergent extraction) of 32 diverse corn silages were determined to partition digestion into in vitro digestible NDF (IVdNDF) and digestible neutral detergent solubles (IVdNDS) and to study the factors affecting these fractions. Dried silages were fermented whole or after grinding through 4 or 1-mm screens for 24 h in a rotating jar in vitro system. For whole silages, ranges in variables were: IVDMD, 45-78%; IVDMT, 59-83%; IVdNDF, 5-30%; and IVdNDS, 24-63%. Results for 4 and 1-mm ground silages were similar and ranges were: IVDMD, 59-82%; IVDMT, 68-85%; IVdNDF, 10-33%; and IVdNDS, 37-68%. Range in estimated TDN by the NRC summative equation (63-75%) were narrower than IVDMD. Digestible NDF accounted for 10 to 50% of IVDMD regardless of physical form, indicating that neutral detergent solubles (NDS) were the primary contributor to DM digestibility. When corrected for ash, the relationship between IVdNDS and NDSom had a slope 0.98 and intercept of zero for 1 and 4-mm silages with $R^2 > 0.95$. The relationship for whole forages was similar, but R^2 were lower and residuals were large. For 1 and 4-mm silages, R^2 were improved by the addition of total starch and IVDMD of corn grain, indicating that starch affects IVdNDS. Residual deviations were reduced for whole silages by including the proportion of DM in starch from particles >4.75 mm and silage DM. For all materials, IVdNDF was related to aNDF or aNDFom and ADL or the ratio of ADL:aNDF. For 1-mm silage, $IVdNDF = 0 + .6[aNDF - 4.5(ADL)]$, $RMSE = 2.14$. The regression coefficient for aNDF was similar for 4-mm and whole silages, but the coefficient for ADL was larger (5.1 to 8.2). The TDN summative equation agreed with 4-mm IVDMD; however, it tended to over predict dNDF and under predict dNDS (dCP + dNFC + dEE) compared with IVdNDF or IVdNDS. Improved equations for predicting corn silage digestibility will require coefficients for starch content, particle size and availability and refined relationships between ADL and dNDF.

Key Words: TDN, Fiber, Digestibility

827 Effects of pretrial milk yield on feed intake, production, and feeding behavior responses to forage particle size by lactating cows. G. M. Burato*¹, J. A. Voelker², and M. S. Allen², ¹University of Padova, Italy, ²Michigan State University, East Lansing, MI.

Forage particle size can affect dry matter intake, chewing activity, digestibility, and yield and composition of milk for lactating cows. However, it is not known if cows varying in milk yield respond differently to differences in particle size of forages in their diets. Thirty-two Holstein cows (152 ± 78 DIM; 684 ± 71 kg BW; 2.79 ± 0.66 BCS; mean \pm SD) received two diets according to a crossover design with 16 d periods. Milk yield averaged 36.6 kg/d and ranged from 24.1 to 49.3 kg/d for the 14 d prior to initiation of treatments. Diets had similar composition (DM basis: 30.8% NDF, 20.9% ADF, 19.8% CP, 23.4% starch) and differed only in the particle size of alfalfa hay (28% of dietary DM). The long diet (L) contained coarsely chopped alfalfa hay, whereas the same hay was chopped twice through a hammer mill (3.2 cm mesh screen) before being included in the short diet (S). Both diets were offered ad libitum (5% orts) as a TMR. Different DM percentages were found for L and S diets on upper (11 vs. 0%) and middle sieves (32 vs 35%) and in the bottom pan (57 vs. 65%) of the Penn State separator. Treatments had no effect on DMI, milk yield, milk fat, milk protein, change in BW or BCS, or on total chewing or rumination time per day. Eating time increased for L treatment (229 vs. 202 min/d, $P < 0.001$). Cows across the range of milk yield responded similarly to treatments. No effects of pre-trial milk yield on response to diet particle size (L-S) were observed for DMI, milk yield, or percentages of milk components. The ratio between the NDF retained by each sieve of the Penn State separator for orts and the corresponding fraction in the original diet showed that selection against coarse NDF (upper plus middle sieves) increased with pre-trial milk yield for the L diet ($R^2 = 0.23$, $P = 0.02$). This feeding behavior response reduced the original difference in particle size between

the experimental diets. Selective feeding behavior, as well as the relatively high dietary NDF concentration used in this experiment, resulted in no effect of diet particle size on feed intake and milk production.

Key Words: Lactating Cows, Forage Particle Size, Feed Selection Activity

828 In situ digestibility and ruminal retention time of feed particles with functional specific gravity higher or lower than 1.02. A. N. Hristov*¹, S. Ahvenjarvi², P. Huhtanen², and T. A. McAllister³, ¹Department of Animal and Veterinary Sci., University of Idaho, Moscow, ID 83844-2330, ²MTT Agrifood Research Finland, FIN31600 Jokioinen, ³Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB T1J 4B1.

Ruminal content was separated into particles with functional specific gravity (SG) higher or lower than 1.02 (HP and LP, respectively) and their mean ruminal retention times (MRT) and indigestible neutral detergent fiber (iNDF) concentrations were compared. Whole ruminal contents from two lactating cows fed an all-grass silage diet were separated into HP and LP in NaCl solution (SG = 1.02) and washed through a 200-micron mesh (HP and LP) and a 38-micron mesh (HP only). Whole grass silage (WGS) was labeled with lanthanum, HP with erbium and LP with dysprosium. In a crossover study with four Ayrshire cows and two diets (100% grass silage and 50% grass silage:50% concentrate), labeled HP, LP and WGS were pulse dosed simultaneously into the rumen and whole ruminal contents were sampled 20 times over the next 72 h to determine markers MRT. Fractions arising from wet-sieving HP and LP were incubated in situ to determine iNDF contents. Diet did not affect ($P > 0.05$) ruminal MRT of labeled particles. The MRT of LP (22.5 h) was shorter than that of WGS (29.2 h, $P < 0.05$) or HP (28.8, trend at $P < 0.1$). The 0.038-, 0.08-, 0.16-, 0.315- and 0.63-mm sieves retained more ($P < 0.05$) dry matter from HP than from LP; the 2.5-mm sieve retained more ($P < 0.05$) from LP than from HP. Except for 0.16 mm, all sieve fractions from HP contained more ($P < 0.05$) iNDF than those from LP. Overall, HP had higher ($P < 0.05$) iNDF content than LP (45.3 vs 41.8%). Across SG, iNDF content increased ($P < 0.05$) with increasing sieve size up to 0.63 mm, and was lower ($P < 0.05$) in particles larger than 2.5 mm. This study indicates that ruminal particles with SG higher than 1.02 have higher iNDF content and tend to reside longer in the rumen than those with SG less than 1.02.

Key Words: Ruminal Particles, Specific Gravity, Digestibility

829 Differences among carbohydrates in yields of crude protein from in vitro fermentation with mixed ruminal microbes. M. B. Hall*¹ and C. Herejk¹, ¹Dept. of Animal Sciences, University of Florida.

The yield of microbial crude protein (CP) from carbohydrate fermentations was examined using trichloroacetic acid (TCA) precipitation of batch cultures. The medium contained ammonium bicarbonate, casein acid hydrolysate, and cysteine hydrochloride as nitrogen sources. Isolated bermudagrass neutral detergent fiber (iNDF) and 60:40 blends of iNDF and sucrose (Suc), citrus pectin (Pec), or corn starch (Sta) (375 mg of substrate organic matter (OM)/vial) were fermented in vitro in two separate fermentation runs with mixed ruminal microbes. Three fermentation tubes for each substrate were destructively sampled at 0, 4, 8, 12, 16, 20, and 24 h. Fermented samples were precipitated at a concentration of 19.4% TCA, and filtered to collect unfermented iNDF and precipitate. Collected residues were analyzed for CP as Kjeldahl N x 6.25. Microbial CP (TCACP) was estimated as TCA-precipitated CP corrected for the TCA-precipitated CP content of substrates at 0 h, and the mean of fermentation blanks from each hour. Medium pH did not decline below 6.49 in any fermentation tube. Heterogeneity of regression analysis of TCACP yield over time for iNDF vs. other substrates, Pec + Sta vs. Suc, and Pec vs. Sta indicated that the compared curves were not parallel ($P < 0.05$). The patterns of TCACP yield over time were cubic for iNDF and Suc, and quartic for Pec and Sta. The maximal yields of TCACP predicted from the regressions were Sta: 34.0 mg at 15.6 h, Pec: 29.9 mg at 13.5 h, Suc: 25.5 mg at 12.5 h, and iNDF:13.6 mg at 19.3 h. Comparisons of maximal yields based on the hour in which the measured mean yield was greatest for each substrate in each fermentation indicated that starch > sucrose = pectin > iNDF ($P < 0.05$). All substrates showed increases in TCACP to their maxima, followed by declines in TCACP. This likely reflects the relative dominance of microbe production or degradation about the point of substrate limitation. Unlike other substrates, Suc had no detectable lag, and presented

a much flatter TCACP yield curve than the other non-NDF carbohydrates (NFC). The NDF and NFC carbohydrates examined differed in both yield and pattern of yield over time of TCACP.

Key Words: nonfiber carbohydrate, microbial protein, rumen fermentation

830 Endogenous N-losses in the digestive tract of dairy cows; influence of low digestible fiber. W.J.H. Van Gestel*¹, G. Hof¹, J. Dijkstra¹, and S. Tamminga¹, ¹Wageningen Institute of Animal Sciences, Wageningen, The Netherlands.

In dairy cattle, about 30 % of the excreted nitrogen in feces and urine is considered to be of endogenous origin. The amount of fecal endogenous N (EN) loss likely depends on amount and composition of the diet fed. In the Dutch DVE/OEB protein evaluation system, a fecal EN loss of 8 g N per kg indigestible dry matter (IDM) is expected. This figure is derived from extrapolation of observed fecal N at various N-intake levels to a N-intake of 0. In this study, the influence of IDM passage on EN loss was investigated in a more direct way in a dose response set up, with IDM administered via two routes, and in two particle sizes. Four dairy cows, fitted with a dorsal rumen canula, were fed a basal ration of a mixture of grass- and maize silage, 1:1 on DM base, and concentrates according to individual requirements. In addition to this control diet (treatment 1), the animals received 3 kg of wheat straw as 0.5 mm particles infused in the abomasum (treatment 2) or orally (3) and as chopped straw orally (4) according to a 4x4 Latin square design. The extra fecal N, relative to the control, was corrected for indigestible N in the straw (ADIN, 1.51 g/kg DS) and undigested microbial N from straw fermented in the rumen (treatment 3 and 4), assuming that per kg unrecovered extra DM 24 g microbial N was produced, with a digestibility of 85%. The corrected extra N was considered the EN-loss due to the extra IDM. The addition of straw to the basal ration resulted in a significantly enhanced fecal excretion of DM (173% of the control) in treatment 2. The recovery of the extra DM was somewhat lower for treatment 3 and 4, due to rumen fermentation of the straw. There was a significant extra excretion of EN 3.4 - 6.0 (se 1.2) g per kg extra fecal IDM, which was also significantly lower than the expected value of 8 g per kg IDM. No significant differences were observed between treatments 2, 3 and 4. Therefore, EN loss due to IDM was not influenced by particle size and way of administration of the extra DM.

Key Words: Endogenous N, Dairy Cows, NDF

831 An investigation of feeding level effects on digestibility for diets based on grass silage and high fiber concentrates at two forage : concentrate ratios. F.J. Mulligan*, P.J. Caffrey, M. Rath, J.J. Callan, and F.P. O'Mara, University College Dublin.

The objective of this study was to investigate the effect of feeding level on diet digestibility at two forage : concentrate ratios for diets containing grass silage. Four rumen fistulated Holstein/Friesian steers were used in a latin square design comprising a 2 x 2 factorial arrangement of treatments. Treatments were maintenance (M) and 1.6-M feeding level and 500 or 850 g/kg dry matter (DM) soya hulls. Digestibility was determined by total collection and rate of digestion was determined in-sacco. Fractional soya hulls rumen outflow rate (k1p) and fractional solute rumen outflow rate (k1f) were determined using Cr-mordanted soya hulls and Co-EDTA. Increasing feeding level and soya hulls inclusion decreased the digestibility of diet DM, organic matter (OM), crude protein, neutral detergent fiber (NDF), acid detergent fiber (ADF) and gross energy (GE) ($P < 0.01$). As the interaction of feeding level and forage : concentrate ratio was significant for GE digestibility ($P < 0.05$), and approached significance for DM and OM digestibility ($P = 0.06$, for both), the depression due to feeding level was greater for 850 g/kg DM soya hulls diets and the depression due to soya hulls inclusion was greater for the 1.6M diet. The rates of digestion of slowly degradable soya hulls DM ($P < 0.05$) and NDF ($P = 0.07$) and grass silage DM and NDF ($P = 0.08$ and 0.09, respectively) were lower for high concentrate diets. Soya hulls k1p and k1f increased with feeding level but only the increase in k1f was significant ($P < 0.01$). Diet OM, NDF and GE digestibility were positively related to rumen pH six hours after feeding ($P < 0.01$; $R^2 = 0.50$ to 0.69). These results indicate that feeding level induced digestibility depressions are larger for high concentrate diets due to lower rumen pH values and lower rates of concentrate and forage digestion. These effects may cause important inaccuracies in rationing systems for ruminants.

Key Words: Digestibility, Intake, Forage : Concentrate Ratio

832 Effect of a targeted B-vitamin regimen on rate and efficiency of fast growing broilers from 0 to 49 days. M Coelho, W McKnight*, and B Cousins, *BASF Corporation*.

Nine thousand eight hundred, day old male Cobb X Cobb broilers were utilized in a 5x2 factorial design (10 replications/treatment) to determine the effects of five B-vitamins (riboflavin, pantothenic acid, niacin, B12 and folic acid) fortification levels (NRC, 2X, 4X, 8X and 16X NRC) and two levels of stress (low and moderate) on the performance of 0-49 day broilers. Diets were formulated to be isocaloric and isonitrogenous. The starter diet was fed in crumble form and the grower and finisher diets in pellet form. Across stress levels, broilers at 21 days had body weights of 645^e, 666^d, 693^c, 704^b and 715^a grams and corrected feed efficiency of 1.438^d, 1.410^c, 1.388^b, 1.376^{ab} and 1.371^a when supplemented with NRC, 2X, 4X, 8X and 16X NRC B-Vitamins, respectively. Carcass dry yield increased as vitamin supplementation increased (65.5^c, 66.3^{bc}, 66.7^{bc}, 67.5^{bc} and 68.5^a% for NRC, 2X, 4X, 8X and 16X NRC supplementation, respectively) and breast meat as percent of live weight also increased (16.12^d, 16.36^{cd}, 16.75^{bc}, 17.02^{ab} and 17.19^a% for NRC, 2X, 4X, 8X and 16X NRC supplementation, respectively). Fat pad as percent of live weight decreased with increased supplementation (13.08^d, 12.72^c, 12.55^{bc}, 12.31^{ab} and 12.17^a for NRC, 2X, 4X, 8X and 16X NRC supplementation, respectively). Under moderate stress, broilers fed 4X NRC had a \$0.17/bird advantage and 42X return over the NRC treatment birds. Broilers fed 16X NRC levels had a \$0.18/bird advantage and 10X (1000%) return over 2X NRC and \$0.13/bird advantage and 8X (800%) return over 4X NRC.

Key Words: Broilers, Vitamins, Performance

833 Impact of glutamine, Menhaden fish meal and spray-dried plasma on the growth performance and intestinal morphology of broilers. G.F. Yi*¹, G.L. Allee¹, J.W. Frank¹, J.D. Spencer¹, and K.J. Touchette¹, ¹*University of Missouri-Columbia*.

A 21-day trial was conducted to evaluate the effects of glutamine (GLN), Menhaden fish meal (MFM), and spray-dried plasma (SDP) on the growth performance and intestinal morphology of broilers. A total of 378 1-d-old male broilers were randomly allotted to one of nine treatments, with six replicate pens per trt and seven birds per pen. Trt 1 was a corn-soybean meal control diet. Trt 2 to 8 were 3%, 6%, or 9% MFM or 3%, 6%, or 9% SDP diets, and a 9% MFM + 3% SDP diet, respectively. Trt 9 was the control diet supplemented with 1% GLN. Body weight (BW), body weight gain (BWG), feed intake (FI) and gain:feed ratio (G:F) were used to evaluate the growth performance. At d 3, 7 and 14, villus height (VH), crypt depth (CD) and VH:CD ratio (CVR) of duodenum and jejunum were used to compare the intestinal morphology of broilers. Breast muscle weight and tibia ash was measured to evaluate the effects of MFM on breast muscle and tibia growth at d 21. From d 0 to 3, feeding 3% SDP improved the BW and BWG ($P < 0.05$) compared to broilers on the control diet. During wk 1, feeding 3% SDP improved BW and BWG relative to all the other dietary treatments except the 6% MFM diet ($P < 0.05$). At d 21, no significant differences were observed between BW, BWG, and FI among treatments ($P > 0.05$). At d 3, feeding 9% MFM or 1% GLN tended to decrease CD of both the duodenum and jejunum compared to the birds fed the control diet ($P < 0.10$). No significant differences between VCR of either duodenum or jejunum were observed at d 3, 7 or 14 after hatch ($P > 0.05$). There were no significant differences between breast muscle weight and tibia ash among treatments at d 21 ($P > 0.05$). These results suggest that additional research is needed to understand the role that these special ingredients may have in a prestarter diet for broilers.

Key Words: Broilers, Glutamine, Spray-dried plasma

834 Impact of glutamine, Menhaden fish meal and spray-dried plasma on the growth performance and intestinal morphology of turkey poults. G.F. Yi*¹, G.L. Allee¹, J.D. Spencer¹, J.W. Frank¹, and A.M. Gaines¹, ¹*University of Missouri-Columbia*.

A 21-day study was conducted to determine the effects of glutamine (GLN), Menhaden fish meal (MFM) and spray-dried plasma (SDP) on the growth performance and intestinal morphology of turkey poults. A total of 336 1-d male turkey poults were randomly allotted to one of

eight dietary treatments, with seven replicate pens per trt and six birds per pen. Trt 1 was a corn-soybean meal control diet. Trt 2 to 7 contained 3%, 6%, 9%, or 12% MFM, or 1.5% and 3% SDP, respectively. Trt 8 was the control diet supplemented with 1% GLN. Body weight (BW), body weight gain (BWG), feed intake (FI) and gain:feed ratio (G:F) were used to evaluate the growth performance. Villus height (VH), crypt depth (CD) and VH:CD ratio (VCR) of duodenum and jejunum were used to compare the intestinal morphology of birds at 7 and 21 days after hatch. From d 0 to 7, feeding 1% GLN improved the BW, BWG and G:F compared to birds fed the control diet ($P \leq 0.05$). Compared with the birds fed the control diet, the addition of MFM was 3% to 12% resulted in a linear increase ($P < 0.05$) in BW, BWG, and G:F, and SDP addition from 1.5% to 3% resulted in a linear increase ($P < 0.05$) in G:F. During wk 2, the addition of MFM resulted in a linear increase ($P < 0.05$) in FI relative to birds on the control diet. From d 0 to 14, feeding 1% GLN improved the G:F relative to all the other dietary treatments except the 12% MFM diet ($P < 0.05$). At d 21, there were no significant differences between BW, BWG, and FI among treatments ($P > 0.05$). Compared with the control diet, feeding 1% GLN improved the G:F significantly ($P < 0.05$). At d 7 or 21 after hatch, no significant differences were observed between the VH, CD, or VCR in the duodenum or jejunum among treatments ($P > 0.05$). These results indicate that these special ingredients may have a beneficial role in prestarter diets for turkeys.

Key Words: Turkeys, Fish meal, Glutamine

835 Apparent ileal digestibility of amino acids in soybean meal, Menhaden fish meal, catfish meal and spray-dried plasma in young broilers. G.F. Yi*¹, G.L. Allee¹, H.J. Liu¹, J.W. Frank¹, and J.D. Spencer¹, ¹*University of Missouri-Columbia*.

This trial was conducted to determine the apparent ileal digestibility of amino acids (AA) in soybean meal (SBM), menhaden fish meal (MFM), catfish meal (CFM) and spray-dried plasma (SDP) in young broilers. A total of 120 21-day-old male broilers (809±20 g) were randomly allotted to one of the four dietary treatments with six replicate pens per trt and five birds per pen. All birds were fed similar diets prior to being fasted for 20 h. Birds were then refed semi-purified corn starch diets for 5 h, where SBM, MFM, CFM or SDP served as the only AA source. Chromium oxide (Cr₂O₃ at 0.1% of diet) was supplemented as the indigestible marker. After refeeding, all the birds were killed to collect ileal digesta (the ileum defined as the portion of the intestine extending from the Meckel's diverticulum to the ileo-cecal junction). The AA and Cr₂O₃ content of the experimental diets and ileal digesta were measured to calculate the apparent ileal AA digestibility. The results indicated that among those four tested AA source, SDP had the highest AA digestibility while CFM had the lowest Lys, Met+Cys, Thr, Trp, Leu, Ile, Val, Phe+Tyr, Arg, His, Gly, Ser, Asp, Glu, Pro, Ala, essential AA, non-essential AA, and total AA digestibility ($P \leq 0.01$). Compared with SBM, MFM had higher Cys+Met, Leu, Thr, Ile, Val, Gly, Pro, Ala, essential AA, and total AA digestibility ($P \leq 0.01$). This research shows that the AA digestibility of SDP for young broilers is higher than all other tested protein sources. Compared to SBM, MFM was found to have higher digestible AA for young broilers, while CFM was found to be inferior to SBM.

Key Words: Fish meal, Ileal AA digestibility, Spray-dried plasma

836 Evaluating potential value-added sorghums for the poultry industry. A Johnson*, J Fulton, J Akridge, and M Latour, *Purdue University, West Lafayette, Indiana, USA*.

Sorghum is considered in broiler feed formulations in the regions where broiler and sorghum production overlap. Nutritionists have noted sorghum's variability of crude protein and essential amino acids (CP-EAA) as problematic in poultry diets. The sorghum industry is seeking opportunities to develop specialty hybrids that meet the needs of the poultry industry and ensure a long-term customer. One possibility is to address the main concern of many nutritionists about sorghum by reducing the variation of CP-EAA. Other possibilities that could be coupled with this reduction in variation of CP-EAA include an increase in the concentration of lysine and an increase in the CP-EAA levels. The expectation is that all three enhanced sorghums would result in more efficient broiler production through less waste of feed nutrients. The

benefits these enhanced sorghums might bring to the broiler industry could also be displaced by technology. The use of Near Infrared (NIR) grain analyzers would allow the mixing of rations using the actual nutrient profile of the ingredients. This process is expected to reduce the amount of wasted nutrients. This study estimates the effects on feed expenditures for five alternative scenarios: a BASE scenario (simulation with currently available sorghums), a sorghum hybrid with a reduced variation in CP-EAA (RV), a sorghum hybrid with RV and enhanced lysine concentration, a sorghum hybrid with RV and higher levels of CP-EAA (HPRV), and the adoption of NIR technology. The impacts of the enhanced sorghum and technology scenarios are determined by comparing estimated feed expenditures to the BASE scenario. The simulation model incorporates a least-cost feed formulation, stochastic CP-EAA levels of feed ingredients, and a broiler growth model. The simulation was run for each scenario for five years. Annual prices paid by poultry producers were used. The HPRV scenario was the only one that was in the efficient set for all three of the efficiency criteria used. This indicates that a sorghum hybrid that has increased levels of CP-EAA coupled with a reduction in the variation of CP-EAA holds the most promise for the broiler industry in terms of feed expenditure efficiency.

Key Words: Poultry Nutrition, Value-Added Grain, Poultry Management

837 Effects of seed coat and plant color in sorghum on growth of broiler chicks. C. L. Jones^{*1}, J. D. Hancock¹, J. F. Pederson², C. W. Starkey¹, and D. J. Lee¹, ¹*Kansas State University, Manhattan, KS*, ²*USDA-ARS, Lincoln, NE*.

A total of 960 broiler chicks (1 d old) were used in a 14-d growth assay to determine the effects of seed coat (pericarp) and necrotic plant color on growth performance. Treatments in the experiment were sorghums with: 1) red pericarp/purple plant color; 2) red pericarp/tan plant color; 3) white pericarp/purple plant color; and 4) white pericarp/tan plant color. The 20 sorghum lines used in the experiment were 97% genetically identical except for those genes for pericarp and plant color. The sorghums were ground through a Prater Pulverizer[®] hammermill to a mean particle size of 600 microns and incorporated into diets with 1.2 % lysine, 1.1% Ca, and 0.5% available P. When the diets were fed to chicks, no differences were observed for ADG ($P > 0.36$) or ADFI ($P > 0.35$). As plant color was changed from purple to tan in the red pericarp sorghums there was little effect on gain/feed, but in the white sorghums, gain/feed tended to increase as plant color was changed from purple to tan (pericarp x plant color interaction, $P < 0.06$). In conclusion, pericarp and plant color did not affect ADG or ADFI of broiler chicks. But, there was a trend for improved gain/feed when white seed coat color was combined with tan plant color.

Item	Red/purple	Red/tan	White/purple	White/tan	SE
ADG, g	23.1	23.0	22.8	23.3	0.4
ADFI, g	32.6	32.7	32.9	32.2	0.5
Gain/feed, g/kg	709	703	693	724	9

Key Words: Sorghum, Food-quality, Chick

838 The effect of using different levels of tilapia by-product meal in broiler diets. L. E. Ponce and A. G. Gernat^{*}, *Escuela Agrícola Panamericana/Zamorano, Tegucgalpa, Honduras*.

The tilapia industry in Central America has grown significantly. Much waste is generated by the industry due to the fact that only the myomere muscles are removed (filleted) and commercialized. This portion constitutes approximately 36% of the entire fish, leaving the remaining 64% of the fish as waste lost during the various processing operations. This waste from the tilapia processing plant has the potential of being an alternative protein source in broiler rations. The objective of this study was to measure the effect of substituting different levels of tilapia by-product meal (TM) for soybean meal (SBM) in broiler diets. For the experiment 0, 10, 20, 30, 40, and 50% of the crude protein contributed by the SBM in broiler diets was substituted by crude protein from TM. The control and five levels of TM were used in a corn-soybean based diet and fed to chicks from 0-42 days. Chicks were identified and randomly allocated in a randomized complete block design. Body weight, cumulative feed consumption, feed conversion ratio, and mortality were determined on a weekly basis. At processing, carcass weights and yields were determined on a prechilled basis. Results show that the 10 and 20% TM group had significantly ($P \leq 0.05$) improved body weights from 14

to 28 d of age compared to the other treatments. No significant differences were found for the remaining 35 to 45 d body weights, cumulative feed consumptions, feed conversion ratios, mortalities, carcass weights or yields for any of the treatments. In conclusion, this particular TM can be used at levels up to 50% without negatively affecting bird performance or carcass quality.

Key Words: Tilapia, Tilapia by-product meal, Soybean meal

839 Nutritional value of wheat screenings for broiler chickens. G Audren^{*}, H Classen, and K Schwan, *University of Saskatchewan, Saskatoon, SK, Canada*.

Two trials were conducted to study the nutritional value of two wheat screening samples in broiler diets. Experiment 1 evaluated the chemical composition, energy, and amino acid digestibility of two wheat screening samples. Experiment 2 evaluated the performance of 1980 female broiler chickens, housed in straw litter pens, and fed different levels of the two wheat screening samples. In the latter study, the wheat screening samples replaced 0%, 25%, 50% and all of the wheat in diets fed to broilers. Each diet had 6 replications with 55 birds per replication. The metabolisable energy, protein content, and mean ileal amino acid digestibility were 3107 kcal/kg, 15.77%, 83.3%, and 3023 kcal/kg, 15.19%, 80.4% for the wheat screening samples 1 and 2, respectively. The samples contained 90.5% or 88.2% wheat and the major weed seed in both samples was wild buckwheat, which was 4.5% or 6.3% in samples 1 and 2, respectively. In the broiler feeding trial, no significant differences were found between the wheat diet and those containing wheat screenings with regards to growth, feed efficiency, and mortality. There were variations in the composition of wheat screening samples, however in this study, these variations did not significantly affect the performance of broiler chickens. Wheat screenings totally replaced wheat in balanced broiler diets without affecting performance.

Key Words: Broiler, Feed, Wheat Screenings

840 Use of cottonseed meal for broiler breeder pullets. N. M. Dale^{*}, J. L. Wilson, and A. J. Davis, *University of Georgia*.

The two major challenges facing producers of broiler breeder pullets are: 1) to prevent the accumulation of excess body weight, and 2) to maintain a reasonable degree of body weight uniformity in the flock. It is frequently difficult to maintain satisfactory flock uniformity while imposing the degree of feed restriction needed to maintain appropriate body weights during the rearing period especially when using soybean meal as the main dietary protein source. It is hypothesized that by using a less nutrient dense protein source, such as cottonseed meal (CSM), it may be feasible to restrict body weight gain in developing pullets without having to resort to extreme feed restriction. This should lead to improved flock uniformity. In a preliminary study, 8 replicates of 8 mixed sex Ross x Ross chicks were assigned to each of four dietary treatments: 1) a typical broiler starter diet, 2) a soy based pullet rearing diet, 3) a cottonseed meal (with added soapstock) based diet, formulated to the same nutrient specifications as #2, and 4) as #3, with soapstock-free CSM. After two weeks, body weights (relative to diet 1 were 75.1, 63.1, and 62.7%, respectively. Relative feed conversions were 131.5, 138.5, and 149.2%, respectively. These data confirm the potential of CSM in restricting growth. In a subsequent experiment, six hundred Cobb breeder pullets were reared to 2 weeks of age on a standard pullet starter diet. At this time, they were divided into two treatments of 300 pullets each and reared on pullet grower diets with either soybean meal (SBM) or cottonseed meal (CSM) as the major protein source. Feed was administered to both treatments so as to achieve the body weights recommended by the breeder. Pullets receiving the CSM diet gained less weight than those receiving the SBM feed, even though they consumed approximately 15% more feed than SBM controls. This led to an improvement in body weight uniformity.

Key Words: Broiler breeder pullets, Cottonseed meal

841 Comparison of broiler performance and carcass characteristics when fed B.t., parental control or commercial varieties of dehulled soybean meal. C.A. Kan*¹, H.A.J. Versteegh¹, T.G. Uijttenboogaart¹, H.G.M. Reimert¹, and G.F. Hartnell², ¹ID-Lelystad, P.O. Box 65, 8200 AB Lelystad, The Netherlands, ²Monsanto Company, 800 N Lindbergh Blvd, St. Louis MO 63617.

The nutritional value of diets containing solvent extracted dehulled soybean meal from (transgenic) B.t. soybeans and soybean meal from control and commercial lines of soybeans—all comparably processed—on broiler performance was evaluated and effect on carcass yield and body composition assessed. The following soybeans were included in the study: a non-transgenic soybean parental control line (A3237), two test lines (726 and 781) and seven commercial varieties (A1900, A2069, A2247, A2869, A3244, A4341 and A4922). The study lasted for 41 days and each treatment group consisted of ten replicate pens (5 with males and 5 with females) starting with 12 broilers and culled to 9 broilers per pen at 13 days. Day old sexed commercial Ross 508 broilers were used and bodyweight and feed intake were measured per pen at 41 days. At 42 days 4 broilers per pen were slaughtered and yields were determined. The carcasses were dissected later and cut-up yields of the valuable parts determined. Dry matter, protein and fat contents of breastmeat were determined on the excised material. Birds performed exceptionally well with body weights and feed conversion averaging over 2400 g and less than 1.60, respectively, at day 41. The data were analysed by an ANOVA procedure. There were no significant treatment x sex interactions. The effect of sex was (as could be expected) significant for some traits. All performance (final weight, feed conversion), carcass yield (weight, slaughter, evisceration, breastmeat, thigh, drumsticks, wings, remaining yields) and breastmeat composition (dry matter, protein and fat) measurements of broilers fed B.t. soybean meal were comparable ($P > 0.05$) to those fed their respective controls and the population fed commercial soybean meals. B.t. soybean meal is substantially equivalent to non-B.t. soybean in nutritional value.

Key Words: Soybean Meal, Nutritive Value, Broiler Body Composition

842 Evaluation of identity preserved soybean meal and amino acid density in broilers. R A. Swick*¹ and K. Huang², ¹American Soybean Association, Singapore, ²Gold Coin Services, Singapore.

A broiler study was conducted in Malaysia to compare performance of broilers fed diets containing identity preserved (IP) U.S. soybean meal (SBM) or commercially available (CA) SBM obtained from a local feed mill. Each meal was incorporated into diets containing 90%, 100% and 110% of NRC recommended minimums for amino acids (constant energy) resulting in a 2 x 3 factorial arrangement of treatments. Equal numbers of feather sexed Cobb 500 broilers were grown in 48 slatted floor pens (70 per pen) for an initial total of 3,360 birds. Analytical results of the SBM for CP (Kjeldahl), CF, DM, lys, met, thr, available lys, urease, protein dispersibility index, protein solubility in 0.2% KOH and initial predicted ME(n) were: IP- 49.8, 2.49, 88.3, 3.07, .72, 1.92, 2.86, .02, 28.7, 77.8, 2513; CA- 48.2, 2.01, 89.1, 2.96, .67, 1.88, 2.73, .02, 28.0, 76.4, 2506 respectively. Starter, grower and finisher diets were least cost formulated based on the nutrient values analyzed and prevailing local market prices for corn, corn gluten meal, meat and bone meal, SBM, palm oil, D,L-methionine, L-lysine HCL, L-threonine, vitamins and minerals. At 49 days, no differences were detected in performance of birds fed the different soybean meals ($P > .05$). Feed cost and feed cost per kg liveweight however, were less with the IP meal because of its higher nutrient levels. For amino acid density (across soybean meal sources), body weight (g) and feed conversion were: 90%: 2.228^a, 2.042^a; 100%: 2.443^a, 1.955^b; 110%: 2.465^a, 1.950^b. No SBM by amino acid density interactions were detected ($P > .05$). In conclusion, the results show that commercial diets should be formulated based on analyzed nutrient levels of SBM and that cost-performance should be considered before formulating with higher than recommended amino acid levels.

Key Words: Soybean meal, Identity preservation, Amino acids

843 Chemical analysis and feeding value of heat damaged soybean meal. Budi Tangendjaja*¹ and Robert A. Swick², ¹Research Institute for Animal Production, Bogor, Indonesia, ²American Soybean Association, Singapore.

An evaluation of soybean meals (SBM) collected from a heat damaged commercial shipment to Indonesia was conducted. Three distinct samples with colors of dark, tan and normal from the damaged shipment were compared to two other samples from a different shipment considered to be undamaged and of acceptable quality. SBM samples were analyzed chemically for proximate, protein solubility in 0.2% KOH (KOHPS), protein dispersibility index (PDI), urease activity, amino acids and available lysine (AL). Each SBM was incorporated into the same starter diet formulation and fed to broilers in battery cages from 0 to 3 weeks of age. There were 7 birds per cage and 7 cages per replicate with a completely randomized arrangement of treatments. Data was subjected to statistical analysis using the MSU-Stat program. SBM samples did not differ in proximate composition but KOHPS and PDI decreased as color became darker, from 75.4 to 72.3% and from 21.8 to 15.3% respectively. PDI was more affected by heat damage than was KOHPS. The darkest SBM was lowest in total lysine and threonine compared to undamaged SBM. Birds fed diets containing the darkest SBM had 15% less body weight (524 vs. 617g; $P < .05$) and 10% poorer feed:gain ratio (1.602 vs. 1.451; $P < .05$) after three weeks compared to those fed undamaged SBM. Feed:gain ratio was negatively correlated to total lysine (-.99) and AL (-.97). KOHPS and PDI were less strongly correlated to bird performance. In conclusion, feeding value of soybean meal is impaired by heat damage resulting in darkened color. Available lysine and PDI are useful measures of damage in commercial SBM samples.

Key Words: Soybean Meal, Broilers, Protein Dispersibility Index

844 Effect of storage time on the quality of different sources of soybean meal. B. Tangendjaja*¹, E. Wina¹, and R. A. Swick², ¹Research Institute for Animal Production, Bogor, Indonesia, ²American Soybean Association, Singapore.

An experiment was conducted to measure changes in quality of different sources of soybean meal (SBM) stored under tropical conditions. Samples of U.S. dehulled (USD), Brazilian dehulled (BD) and Brazilian non-dehulled (BND) SBM were collected and divided into 6 sealed polyethylene bags each containing 10 kg. One sample of each meal was stored in a warehouse under ambient conditions (ave 27° C and 60-85% RH) and the remaining five were stored in a freezer at -30° C. Each month one bag of each SBM was taken out of the freezer and allowed to be stored in the warehouse. At end of the 5 month period, the SBMs were analyzed for moisture, protein, fat, urease activity (UA), protein dispersibility index (PDI), protein solubility in 0.2% KOH (KOHPS), amino acids, digestible amino acids predicted by NIR, available lysine and 3 week broiler performance. PDI value decreased from 24-30% to 16-25% during 5 months storage but KOH PS did not change significantly. Moisture content increased slightly during storage but protein and fat did not. Total amino acids did not change during storage but digestible lysine predicted by NIR decreased at an average rate of -.019% per month. Individual decreases were: USD -.016%, BD -.025%, BND -.017% NIR digestible lysine per month. No differences in available lysine were detected. UA increased slightly during the 5 month period from 0.10-0.15 to 0.21-0.28 pH unit change. Each SBM sample was incorporated into a balanced diet and fed to 3 replicates of 7 birds per battery cage from 0 to 21 days. Body weight was not affected ($P > .05$) but feed:gain was negatively affected from 1.47 at time zero to 1.52 after five months storage under warm and humid conditions ($P < .05$). In conclusion, SBM quality decreases measurably during storage under tropical conditions. PDI and NIR digestible lysine are useful indicators of these changes.

Key Words: Soybean meal, Protein dispersibility index, Storage

845 Effect of heating solvent extracted soybean in the presence of cysteine or sulfite on ileal true digestibility of protein in broiler chicks. E.L. Miller*, Y.X. Huang, O.C. Fabb, B. Rayner, and S. Kasinathan, Department of Clinical Veterinary Medicine, University of Cambridge.

The objective was to test whether the previously demonstrated effect of cysteine (C) or sulfite (S) in increasing reactive SH and reducing the

heating time needed to reduce trypsin inhibitor (TI) content of soybean resulted in improved ileal true digestibility (TD) of protein. Petroleum spirit-extracted dehulled soybean (TI 58.4 mg/g DM) was adjusted to 780 g/kg DM and heated alone or with either sodium metabisulphite (11.8 g/kg DM) or cysteine (15 g/kg DM) for 25, 35, 55 or 75 minutes at 95°C. Reactive SH, determined by reaction with 4-vinyl pyridine and HPLC separation, was increased by C and S and decreased with heating time. Heating decreased TI 3.9 times faster in the presence of S but not of C. Each of these 12 preparations was included as the sole source of protein in diets formulated for chicks to provide 150, 200 or 250 g CP/kg diet. A diet with enzyme hydrolysed casein plus amino acids (E) as the sole source of protein at 200 g CP/kg diet was used to measure endogenous loss. Chromic oxide was the marker. The diets were offered to 3 cages of 3 chicks (E to 9 cages) ad libitum for 3 days (8 to 10 d of age). Food was removed overnight on day 10 and each cage was fed at timed

intervals ad libitum on day 11 for 4 hours before euthanasia with pentobarbitone sodium given intra peritoneum. TD was calculated as 1-slope of the regression of ileal N per g diet on diet N per g diet using diet E as a zero test dietary N level together with the 3 levels of each test material. TD (mean SEM) soybean alone 0.670.029, 0.780.037, 0.790.026, 0.870.009; +C 0.720.028, 0.860.023, 0.870.014, 0.860.018; +S 0.880.021, 0.890.014, 0.890.013, 0.880.010 at 25, 35, 55, 75 minutes respectively. TD of soybean alone increased with heating time to 75 minutes. The same maximum TD was achieved in 35 minutes with added C and in 25 minutes with added S. The TD achieved with added S was slightly but not significantly greater than the maximum achieved on heating soybean alone (difference 0.0250.0160, *t* 1.56).

Key Words: Ileal digestibility, Sulphite, Heat

AMSA Updates Session

846 Korean Pork 101. D.E. Burson^{*1}, D.B. Griffin², and W.N. Osburn³, ¹University of Nebraska, ²Texas A&M University, ³Michigan State University.

The changing economy and society in Korea combined with market liberalization is changing the Korean meat industry. Western style retailing is being adapted in Korea and has created a need for training. Therefore, the U.S. Meat Export Federation has established the Meat Education and Research Center (MERC) in Seoul, Korea to train butchers and meat retailers in the latest meat merchandising techniques. The National Pork Producers Council, the US Meat Export Federation, Korea, and meat scientists from the University of Nebraska, Texas A&M University and Michigan State University developed a train the trainer program, Korean Pork 101, for MERC instructors. Korean Pork 101 was designed to provide up to date information on pork quality, consistency and value. The course included topics of teaching and workshop methods, an overview of pork production in the U.S., pork quality, meat distribution and shelf life, fabrication value and merchandising, pork specifications, carcass fabrication and pork safety. The three day workshop was conducted with a series of lectures and discussion during an afternoon session and a laboratory demonstration in the evening. Approximately thirty instructors were trained and evaluations indicated that the program was valuable.

Key Words: pork, training, Korea

847 Advanced HACCP course update. N.G. Marriott^{*1}, ¹Virginia Polytechnic Institute & State University.

Since January 25, 2000 all inspected meat and poultry plants are required to have a food safety preventive program known as Hazard Anal-

ysis and Critical Control Points (HACCP). The American Meat Science Association (AMSA) and various professional members have been instrumental in the development of educational material, especially short courses, that has assisted the meat and poultry industry with the implementation of this food safety program. Regulatory requirements of HACCP plan assessment with an emphasis on verification and validation has been attributable to the International HACCP Alliance interest in the accreditation of an advanced HACCP course that will emphasize instruction about verification and HACCP plan validation. During 2000, the AMSA Continuing Education Committee accepted the challenge of the development of an advanced HACCP course to be accredited by the International HACCP Alliance. It was agreed that the content of this course would be developed by AMSA members. The AMSA Continuing Education Committee agreed upon a course content outline and one or more scientists for the development of this 2-day short course. It was decided that the course would be developed as PowerPoint presentations with appropriate handouts and supplementary materials that would be peer reviewed before the AMSA Continuing Education Committee would obtain accreditation from the International HACCP Alliance. The course content will become the property of the American Meat Science Association but available for members' use to present as a short course to the industry. More information about the course content will be discussed. Furthermore, a progress update of material development, peer review, accreditation by the International HACCP Alliance, and material availability to the American Meat Science Association membership will be provided.

Key Words: HACCP, AMSA, Course

Symposium on Concentrated Animal Feeding Operations Regarding Animal Behavior, Care, and Well Being

848 Physiological indicators of stress in domestic livestock. Donald C. Lay Jr.^{*}, *Livestock Behavior Research Unit, Agricultural Research Service-USDA, West Lafayette, IN.*

As with most mammals, domestic livestock will experience varying degrees of both psychological and physiological stress at some time during their life. The objective quantification of these stressful states and application of appropriate measures to limit excessive exposures to stressors is imperative. Proper management of an animal's exposure to stressors will maximize animal well-being and can have beneficial effects on animal production. Although scientists have recognized the deleterious effects of stress for more than 70 years, debates and questions on physiologically assessing its presence in humans and other animals continues to challenge researchers today. Because stress can be defined simply as any physiological change from homeostasis, traditional physiological measurements have relied on quantifying these alterations to homeostasis, such as deviations in heart rate, respiration rate, body temperature, and hormone concentrations. These measurements are still highly relied upon today. It is also well recognized that when these common alterations in baseline homeostatic mechanisms are dramatically altered, an organism's life strategies such as growth, disease resistance, and reproduction can be affected. Therefore, a great deal of research has concentrated on quantifying physiological alterations in these systems, such as

changes in growth and reproductive hormones, changes in populations of lymphocytes, and (or) outward signs of failure of these systems, such as low growth rates, infertility, and an increased number of diseased animals. An area of importance that has been relatively inaccessible are those changes that occur in the central nervous system. Because stress is commonly composed of both a physiological and psychological component, how the animal perceives the stress is critical to assessing its well-being. Physiological measures used thus far to assess the mental response to stress include neuronal activity and measurement of neurotransmitters. Scientists have done a good job of measuring all of these physiological alterations, unfortunately the underlying challenge that continues to confront scientists is how to define the degree of physiological change that translates into distress for the animal.

Key Words: Stress, Livestock, Well-being

849 Influence of stress on composition and quality of meat, poultry, and meat products. E. P. Berg^{*}, *University of Missouri.*

Stress experienced by meat-producing animals prior to slaughter not only influences lean and fat deposition, but also the physicochemical components involved in conversion of muscle to meat. Stressors that

trigger a physiological response can be short term (loud noise, unfamiliar environment, fighting, electric prod goading) or long term (sickness, dehydration, malnourishment, hot/cold stress). Postmortem metabolism in porcine and certain poultry muscles is more rapid than beef or lamb. Metabolism of intramuscular glycogen plays a primary role in the expression of unfavorable meat quality attributes such as dark cutting beef or pale, soft, and exudative (PSE) pork. The level and extent of post-mortem pH decline is glycogen dependent because anaerobic conversion of glycogen to glucose to lactic acid results in an acceptable (or unacceptable) ultimate meat pH. Activation of the sympathetic nervous system in response to a stressor results in mobilization of energy (glucose) from storage (glycogen). Prolonged activation may leave a lesser concentration of glucose available for conversion to lactic acid. The resulting meat will have a high pH (closer to physiological pH), a dark, dry appearance, reduced consumer appeal, a shorter shelf life, and (depending on duration) reduced levels of marbling. Activation of the sympathetic nervous system immediately prior to slaughter is particularly detrimental to swine and poultry. The fight or flight response initiates glycogenolysis and elevates heart rate, blood pressure, and muscle temperature. In this state, stunning and exsanguination will trap heat and lactic acid in the muscle as the system converts to anaerobic metabolism. The accumulation of lactic acid results in a rapid pH decline while the carcass temperature is high. This leads to denaturation and shrinkage of myofibrillar proteins that bind water, and to the development of PSE meat that has little consumer appeal and limited functional value in further processing. The entire meat production system must strive to produce a high-quality product that consumers will purchase repeatedly. Management techniques that reduce preslaughter stress are more easily controlled than postmortem chemical reactions.

Key Words: Stress, Meat quality, Meat production

850 The Free Farmed Program in the US and the Freedom Food Program in the U.K. Adele Douglass*, *Farm Animal Services, 236 Mass Ave., NE, #203, Washington, D.C. 20002.*

A presentation on the Freedom Food Program in the United Kingdom and a history of how the Free Farmed Program came about in the United States. A discussion of the Program description, what are the standards and the costs involved, what are the certification requirements, the assessments and the audits.

Key Words: Farm, Animal Welfare, Animal Behavior

851 Impact of public perception on current and future livestock and poultry production. G. J. Coleman*¹ and P. H. H. Hemsworth², ¹*Monash University, 2**University of Melbourne.*

It is well documented that there is a complex set of economic, political, social and personal factors which impact poultry and livestock production and marketing. It has, however, proven difficult to systematize current knowledge in this area. The aim in this paper is to identify the facets of public perception which impact livestock and poultry production practices and to suggest future impacts on the one hand and possible moderating strategies on the other.

Public perception comprises general attitudes and personal attitudes. General attitudes are those opinions which are collected by surveys and reflect peoples' opinions but, because they are not specifically directed to a particular behaviour, may not be expressed in a specific behaviour. It is useful to distinguish these public opinions from personal attitudes that an individual holds, which are derived from experience and which direct behaviour. Understanding this distinction and the differential impact of the two is important in predicting their effects on future poultry and livestock production and the relevance of education and regulation. Private attitudes are direct predictors of behaviour and are relevant to, for example, meat buying behaviour. General attitudes, on the other hand, influence politicians and regulatory bodies and lead to changes in trade policy and other regulations.

Sustainable poultry and livestock production requires economic viability, ecological viability and social acceptability. Social acceptability impacts on issues such as animal welfare, food safety, genetically modified foods and quality of life for the farmer/stockperson. These issues are likely to affect future production practices through consumer buying behaviour, product standards set by processors and retailers, international trade policy and welfare regulations. Many of these influences are outside the control of the poultry and livestock industries and are driven by special interest groups. Research needs to focus more on assessing

the attitudes and knowledge of the poultry and livestock industries in these areas, developing education programs which inform the public on these issues and developing industry strategies to proactively influence the direction of community opinion and government regulation.

Key Words: attitude, welfare, production

852 The effect of management practices on the stress response in livestock. J.L. Morrow-Tesch*¹, ¹*USDA-ARS Livestock Issues Research Unit, Lubbock, TX.*

Stress is a function of life for farm animals. When the biological cost of responding to a stressor becomes too great to overcome, the animal is in a state of distress. The biological response to stress is not a general one as originally proposed but is dependent on the individual's perception of the stressor. Many factors such as age and genetics influence the perception of a stressor. Because animals respond to a stress by changes in their behavior and physiology, we can measure the components of these changes and increase our understanding of how to manage stress in the animal's environment. Many animal management practices are stressful to livestock including handling animals; mixing, moving and regrouping; weaning; and castrating, dehorning, tail-docking and other painful procedures. Several research groups are focusing on ways to reduce the stress associated with these management practices which is important for enhancing animal well-being. Several examples of ways to manage stress in production systems include reducing social stress through hides (areas where pigs can place their heads to reduce aggressive contacts with pen mates) or olfactory cues, providing environmental enrichment and creating alternative production systems.

Key Words: stress, behavior, management

853 The FASS initiative to develop training materials on farm animal care. John McGlone*, *Texas Tech University.*

The public requires accountability in expenditure of public dollars in teaching and research. The USA Animal Welfare Act, the Public Health Service, the USDA and the Federation of Animal Science Societies (FASS) Guide for the Care and Use of Agricultural Animals in Agricultural Teaching and Research (Ag Guide, 1999) require that people who use animals be properly trained. While training materials have been available for users of laboratory animals for some time, training materials for those who use farm animals in teaching and research have not been available. The FASS board authorized a project to begin development of peer-reviewed educational materials late in 2000 and the first product of this effort was released in March, 2001. The materials in the first package – meant to cover introductory farm animal care topics – include a two-tape digital video, a CD with the Ag Guide and some sample questions to be used in the trainee evaluation. The tape's script was written by three authors (J. McGlone, J. Morrow-Tesch and C. Stull), produced by the FASS office and a local video production company and was reviewed by the FASS Animal Care, Use and Standards committee. More tapes are planned to cover each common farm-animal species. Development of a multi-media and web-based training program will be facilitated by capture of the video in digital format. Collaboration between FASS and The American Registry of Professional Animal Scientists (ARPAS) is underway to develop a certification program for farm animal workers.

Key Words: Animal care, Training, Multimedia

Safety of Our Meat Supply: Assessing the Risks and Methods of Control

854 Risk assessment of pre-harvest food safety: a quantitative approach. S.A. McEwen*¹, ¹*Department of Population Medicine, Ontario Veterinary College, University of Guelph.*

This presentation will demonstrate how pre-harvest food safety risk assessment can be used to guide regulatory decision-making, help to establish policies and standards, and explore impacts of different risk-reduction options. The strengths, limitations and demands of risk assessment in the pre-harvest area will be discussed, using actual examples concerning *E. coli* O157:H7, and antimicrobial resistant bacteria.

We used a quantitative model to assess the benefit of measures implemented in the pre-harvest period that are aimed at reducing the contamination of beef carcasses with *E. coli* O157. Control measures that were assessed were based on either a reduction in herd prevalence of infection, reduction in opportunity for cross-contamination, reduction of concentration of *E. coli* O157 in fresh feces (by vaccination or other method), or a reduction in the amount of feces, mud and bedding ("tag") transferred from the hide to the carcass. Risk assessment is also being used in regulation of veterinary drugs, which will be the focus of the second example. FDA scientists have prepared and publicly presented a risk assessment on the human health impact of fluoroquinolone resistant *Campylobacter* associated with the consumption of chicken. Alternative approaches have been proposed and their strengths and limitations will be discussed.

Demands to enhance pre-harvest food safety continue to mount as microbial and chemical crises occur with amazing regularity around the world. Those concerned with managing risks at the farm level are often pressed to identify which risks can and should be addressed at that level, and at what cost. Risk assessment is gaining acceptance as a valuable tool because of the difficulty in making sound public health decisions in the face of complexity, uncertainty and varying scientific and public opinion. There is a compelling case for a decision-making process that is open and based on scientific evidence, economic analysis and wide consultation with due consideration of societal values.

Key Words: Risk assessment, Food safety, Pre-harvest

855 Pre-harvest Food Safety. J.E. Marion*, *National Chicken Council, Stuart, VA.*

The importance of food safety considerations prior to the slaughter of food animals has been recognized for centuries. It was first recognized that healthy food animals would yield safe food animal products if proper slaughter and processing techniques were followed. Diseases of animal origin that could be transferred to humans have been largely brought under control by vaccines, management, etc. during the past two centuries. During the mid-20th century, food animals were recognized as potential carriers of chemical residues, and programs are now in place to monitor and reduce such residues. More recently, food borne

organisms that affect humans, but not necessarily animals, are being targeted for reduction in numbers and incidence. A most recent foods situation involves bovine encephalopathy (BSE) in European cattle and its' possible relationship to a human form of the disease. All the above situations bring us to a full realization that food safety is a farm-to-table concept that demands programs beyond those for slaughtering and processing. We are compelled to consider all phases from pre-harvest to the consumers plate, and to consider related issues such as environment and waste management. The Hazard Analysis and Critical Control Points (HACCP) approach has been employed by industry and regulatory agencies to accomplish a reduction in food borne pathogens and to model meat and poultry inspection for food safety and wholesomeness aspects. HACCP in poultry plants appears to be successful and will likely be used in broader based programs from the farm to the table. HACCP and other programs will be discussed to illustrate progress in food safety, and to point out areas, especially in preharvest, that need attention. A specific industry program for pathogen intervention will be discussed.

Key Words: Food Safety, Slaughter and Processing Techniques, HACCP

856 Future directions for FSIS and food safety. K. Hulebak*, *USDA Food Safety and Inspection Service, Washington, DC.*

With HACCP now fully implemented nationwide, FSIS is developing a roadmap to enable it to build upon the improvements it has made so far in the safety of meat, poultry, and egg products. Next steps are being considered in many different areas. For example, FSIS has begun to consider and discuss with its stakeholders how the agency's chemical residue program might change as it becomes part of the HACCP approach to ensuring food safety. Through the Workforce for the Future initiative, FSIS plans to implement an ambitious human resource program emphasizing the further development of one of its most valuable resources—the public health professionals who work throughout the agency as inspectors, consumer safety officers, veterinarians, microbiologists, and lawyers, among others. Undertaking reviews of the scientific bases for performance standards will be another important activity within the coming several years. With respect to inspection, FSIS is pursuing a risk-based approach. Education initiatives all along the farm-to-table chain will play a role in FSIS' next steps. And research and risk assessment, the critical underpinnings of all of FSIS' regulatory activities, are receiving ever-increasing emphasis. FSIS is working to enhance its traditional relationship with USDA's Agricultural Research Service, is developing new relationships with USDA's Cooperative State Research, Education, and Extension Service, and is establishing a new Risk Assessment Center to spearhead new risk assessments for *Salmonella* Enteritidis, *Listeria monocytogenes*, and *E. coli* O157:H7. FSIS has initiated a wide-ranging dialogue with stakeholders to explore these next steps.

Soybeans in Monogastric Nutrition

857 Nutrient composition and processing of soybeans impact the nutritional value of resultant soybean meals. C. M. Grieshop* and G. C. Fahey, Jr., *University of Illinois, Urbana, IL/USA.*

It is vital that raw soybeans contain an optimal nutrient profile if the highest quality soybean meal is to be produced. Both soybean composition and processing conditions impact the nutritional quality of soybean meal. In a comparison of soybeans grown in a variety of locations around the world and representing diverse environmental conditions, significant differences in chemical composition (e.g. crude protein, amino acids, and lipid) were noted. These differences could impact the nutritional value of the resultant soybean meals. Little information is available on the impact of processing conditions (e.g. processing time and processing temperature) on the chemical composition and nutritional value of soybean meal. Soybean meals obtained from a large number of U.S. soybean processing plants varied in crude protein, lipid, and amino acid concentrations. Indicators of nutritional value (e.g. protein solubility in potassium hydroxide, urease activity index, and protein dispersibility index) are commonly used to rank soybean meals. United States soybean meals from many processing plants exhibited significant differences in these characteristics. Optimization of both soybean quality and

processing conditions is necessary to produce optimal quality soybean meal that will allow for maximal digestibility and growth performance of animals.

Key Words: Soybean, Soybean meal, Nutrient quality

858 Digestibility of amino acids in soybean meal for poultry. C.M. Parsons*, *University of Illinois, Urbana, IL USA.*

The digestibility of amino acids (AA) in well-processed soybean meal (SBM) for poultry is quite high, with mean digestibility coefficients being 90% or higher. Decreased digestibility of AA is usually due to either insufficient or excess heat processing. Inadequate heat processing results in decreased digestibility of all AA, whereas excess heating usually results in decreased digestibility of only Lys primarily. The reduction in Lys digestibility is due both to destruction of the AA and decreased digestibility of the Lys that is not destroyed. The protein efficiency ratio (PER) growth assay, slope-ratio growth assay and digestibility or balance assays such as the precision-fed cecotomized rooster assay or the chick ileal digestibility assay are all sensitive for measuring bioavailability or digestibility of AA in SBM. A great advantage of the digestibility assays is that all analyzable AA can be measured in the same assay.

When considering *in vitro* or laboratory assays for predicting AA digestibility or protein quality of SBM, the urease assay is good for detecting underprocessing and the KOH protein solubility assay is good for detecting overprocessing. A combination of the latter two assays is needed to ensure that SBM has neither been underheated nor overheated. The protein dispersibility index (PDI) assay may be superior to the urease and KOH assays as an indicator of minimum adequate heat processing of SBM. Determining the Lys concentration as a percentage of the CP may be a good initial indicator of possible overprocessing. Recent work indicates that near infrared reflectance spectroscopy (NIRS) and a new immobilized digestive enzyme assay (IDEA) may also be useful assays for predicting *in vivo* AA digestibility of SBM.

Key Words: Soybean meal, Amino acid digestibility, Poultry

859 Soybean meal quality:swine industry perspective. Keith Haydon*¹, ¹*Heartland Pork Enterprises, Inc.*

Soybean meal (SBM) in swine nutrition has long been the "gold-standard" protein that all other competitive proteins are measured and priced against. SBM provides an excellent amino acid (AA) profile of high true digestibility relative to the pigs' requirement when balanced with corn in a complete feed. The quantity and availability of energy, essential amino acids (EAA) and phosphorous (P) primarily drive SBM quality in the context of swine nutrition. Since energy is the most costly nutrient in swine feeds, the energy value of SBM is critical in formulating

cost efficient diets that provide optimum growth with minimal nutrient excretion and/or energetic losses. Dehulled SBM contains (by difference) approximately 32 to 35% carbohydrates in primarily oligosaccharide forms. Improvement in the digestibility of these components offers tremendous potential in improving the available energy in SBM. Defining the factors that can influence or that can improve the energy value of SBM is paramount to swine nutritionists. Considerable time and effort has been spent over the past 84 years in understanding the impact of required heat treatment of soybeans to neutralize the inherent anti-nutritional factors and their impact on AA availability. The use of protein dispersibility index alone or in conjunction with KOH protein solubility test provides an excellent means to predict adequacy of heat treatment during processing, but are not practical for use in large scale feed mills. Most swine nutritionists surveyed by the author routinely monitor moisture, protein and fiber in SBM. Many have AA analyses performed for quarterly or monthly baselines or predict AA levels from protein levels; however, rarely would they modify their matrix digestibility values based on compositional changes. Increasing the P availability in SBM could decrease diet cost and P excretion and increase dietary energy concentration. Many swine nutritionists consider SBM one of the most consistent quality (nutrient composition and availability) ingredients they use. Areas of concern or opportunity to improve SBM are energy value, consistent processing methodology across the industry and increased P availability.

Key Words: Soybean meal , swine, industry

Twinning Beef Cows

860 Experiences and management of twinner cattle. D. O'Kief*, *O'Kief Ranch, Wood Lake, NE.*

After graduation from the University of Nebraska at Lincoln and before returning to ranching at Wood Lake, NE, Dan O'Kief put his knowledge of reproduction in cattle to work managing Twinner cattle at the United States Meat Animal Research Center at Clay Center, Nebraska. In this symposium on twinning beef cows, Dan will discuss three primary areas related to twinning cow management. These include:

1. The critical period from calving to day three.
2. Improvement of reproductive management of twinning cows.
3. Meeting the mineral and energy demands of twinning cows.

Key Words: Cattle, Twinning, Management

861 Summary of the MARC genetics program to produce twinner cows. R. M. Thallman* and K. E. Gregory, *USDA/ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

The U.S. Meat Animal Research Center (MARC) initiated a program to select cows for increased twinning rate in 1981. Cows that had produced multiple sets of twins were purchased from commercial producers (96 cows) or were transferred from other projects at MARC (211 cows). Semen from 8 Swedish Friesian and 7 Norwegian Red bulls whose daughters twinned more often than normal was imported. Other foundation sires included sons of foundation cows and one Pinzgauer and one Charolais bull whose daughters twinned at high rates in another project at MARC. The herd is 24% Pinzgauer, 18% Simmental, 17% Holstein, 14% Swedish Friesian, 9% Hereford and Angus, 10% Norwegian Red, and 8% other breeds. Current herd size is 300 cows, half calving in spring and half in the fall. Twinning rate (TR) currently averages 50%. Ovulation rate (OR) is used as an indicator trait and is measured by counting corpora lutea via rectal palpation over six to eight estrus cycles prior to breeding heifers for the first time to calve at 30 months of age. The heritabilities of TR and OR are 0.09 and 0.10, respectively, with a genetic correlation of 0.75. Predicted breeding values (PBVs) are computed using a multiple trait, repeated records model for TR and OR. Approximately 10 young bulls are progeny tested per year. Following measurement of their daughters' OR, the best sires are mated to females with the highest PBVs to produce candidates for progeny testing. Response to selection for TR has averaged 2.5% per year. Tissue samples for DNA have been obtained from animals in the herd in 1994 and thereafter. In addition, semen samples were available from most of the sires used prior to 1994. Two quantitative trait loci (QTL) for TR and OR have been identified on chromosome 7 (approximately 60 cM apart) and one on chromosome 5. These three QTL account for about 15% of the genetic variance and are used together with residual polygenic effects in a two-trait model

to compute marker adjusted PBVs, which have been used since 1998. Selection for TR has been effective, in spite of low heritability.

Key Words: Twins, Beef, Genetics

862 Reproductive, growth, feedlot, and carcass traits of twin versus single births in cattle. S. E. Echtenkamp* and K. E. Gregory, *USDA, ARS, RLH US Meat Animal Research Center.*

The production of fraternal twin calves presents a new paradigm in beef cattle management and production and affords an opportunity to increase both reproductive and economic efficiency. The first prerequisite for fraternal twins is twin ovulations. Breeding value for twinning was predicted by repeated measures of ovulation rate in yearling heifers and of twinning rate in the selected herd at the U. S. Meat Animal Research Center. Twinning rate increased 3% per year to an annual rate of 50 to 55%. Gestation length was shorter (275.6 vs 281.3 d; $P < 0.01$) and birth wt was smaller (38.2 vs 47.0 kg; $P < 0.01$) for twin vs single calves, respectively, but total birth wt (live) was increased 53.1% for twins. Respective weaning wt (200-d wt) were 231 vs 259 kg ($P < 0.01$). Number of calves weaned per cow calving was 0.92 for single vs 1.52 for twin births ($P < 0.01$); thus, total weaning wt was increased 47.4% for twins. Single male calves gained 74 g more per d than twin males from birth to 200 d, and 45 g more per d from 200 d to slaughter. Differences in carcass traits between twin and single males were small. Freemartins, 96% of the females born co-twin to a male, did not differ from normal females in growth traits, but freemartins had higher ($P < 0.05$) scores for marbling and a higher ($P < 0.05$) percentage of carcasses were USDA Choice or higher quality grade. Efficiency constraints to twins were increased ($P < 0.01$) incidence of retained placentae (28.0% vs 1.9%), of dystocia (46.9% vs 20.6%) and of perinatal calf mortality (16.5% vs 3.5%); difference in calf survival at 200 d was 14.3%. Dystocia of twins resulted primarily from malpresentation of one or both calves. Fertility was reduced 11.6% ($P < 0.01$) after a twin birth and 9.5% ($P = 0.06$) after a retained placenta, but the effect of twinning on fertility varied significantly ($P < 0.01$) among years and seasons. Collectively, twinning increased productivity at weaning by 54.2 kg or 28.3% per cow exposed at breeding.

Key Words: Twinning, Production, Cattle

863 Management of twinning cow herds. B.W. Kirkpatrick*, *University of Wisconsin-Madison.*

Many beef producers oppose twin birth for the perceived detriments associated with the trait. These include lower calf survival, increased dystocia (malpresentation), increased stillbirth, increased abortion, calf abandonment, retained placenta, lengthened interval from parturition to conception and freemartin heifers when born co-twin with a male. Some of these problems can be overcome with changes in management, others lack an obvious management fix and still others are of little practical significance. Management alterations which may be required for successful exploitation of twin birth include (1) pregnancy checks to determine twin versus single pregnancy, (2) adequate calving facilities and (3) early calf weaning. Determining whether a cow is pregnant with twins eliminates surprises at calving time in that cows at high risk for malpresentation are identified beforehand. In addition, cows gestating twins could be fed a higher plane of nutrition in recognition of the higher demands on them both during late gestation and subsequently while nursing twins. Adequate calving facilities are a necessity given the significant fraction of twin births which are malpresentations. Additionally, availability of calving pens facilities penning of cows with their twins which is sometimes needed to address potential calf abandonment problems. Early weaning is well documented to have beneficial effects on postpartum reproductive performance. Given the typically longer interval from parturition to conception for twin bearing cows, early calf weaning may help maintain adequate reproductive performance. Considering the remaining problems, there are no obvious alterations of management which will improve twinning-related problems with stillbirth, abortion or retained placenta. Freemartinism falls into the last category of something which is more a perceived than real problem. Given that absolute number of fertile females produced from a twinning system will differ little from a single-birth system, freemartinism is not a serious drawback of twinning in beef cattle.

Key Words: Twinning, Cattle, Management

864 Comparison of the profitability of single-calf with twinning cow herds. M. L. Thonney*, *Cornell University, Ithaca, NY.*

A spreadsheet available at <http://www.ansci.cornell.edu/courses/as360/lab/budget.htm> was developed to compare the profitability of cow

herds on 202 hectares (500 acres) of moderately productive forage land with three levels of twinning (1%, 50%, 90%) with or without 2 kg supplement (\$0.12/kg) for 90 days in early lactation expected to maintain fertility in cows with twins to the same level as cows with singles. Purchased hay was priced at \$0.07/kg and extra hay was sold at \$0.06/kg. Land was valued at \$741 per hectare (\$300/acre) and there were about \$62,736 of other capital items. Calf and replacement numbers were determined by twinning rate, fertility, and death rates. Carrying capacity was determined by monthly pasture and hay field productivity and energy requirements of cows with a 10% increase for twinning cows supplied by increased forage or mostly by the supplemental grain mix during early lactation. Cash expenses per cow included extra vet supplies and labor for calving twinning cows which increased as percentage of twinning cows increased (Table). All assets were assumed to be 100% owned. Net farm income accounted for \$8,115 depreciation as well as cash expenses and increased (Table) over single calf herds by 32 and 60% for 50 and 90% nonsupplemented twinning herds and by 61 and 113% for supplemented herds. After accounting for \$3,500 of unpaid family labor and about \$28,600 for possible return on equity, return to operator's labor and management ranged from a loss of \$8,946 for a single-calf herd with 1% twins to a gain of \$17,706 for a supplemented herd with 90% twins. These results show that properly managed twinning cow herds could significantly increase profitability over traditional single-calf cow herds.

Percentage of cows twinning (supplement?):	1 (no)	50 (no)	90 (no)	50 (yes)	90 (yes)
Cows	100	95	91	99	98
Open cows, %	5	10.5	14.9	5	5
Calf loss, %	3.8	11.8	15.8	12.2	15.8
Calves per cow	0.8	1.1	1.3	1.2	1.5
Replacements	15	20	23	16	16
Cash expenses, \$	19,802	21,607	22,137	22,429	23,522
Net farm income, \$	23,411	30,860	37,519	37,768	49,872

Key Words: Cattle, Twinning, Economics

ASAS Horse Species: Historical Aspects of Equine Research—How We Got Here and Where Are We Going?

865 Historical aspects of equine nutrition. H.F. Hintz*¹, ¹*Cornell University.*

The modern horse was introduced to the North American continent in 1519. During the late 1800's and early 1900's a significant number of basic and applied studies were conducted on horse nutrition. Horse research was conducted at many experiment stations and even in territories such as Utah before they became states. However as the number of horses declined, research declined. By 1950, there were no research units at experiment stations dedicated to horse nutrition. As the popularity of horses increased in the 1960's nutrition units were established at several universities including the University of Florida, Texas A&M, University of Kentucky, Cornell University, and University of Minnesota. Research efforts have continued to grow, though not as great as some would like, and it appears the importance of the horse will continue to deserve research support.

Key Words: horse, nutrition, history

866 Effect of fasting on blood lipid concentrations in horses. N Frank*, J Sojka, and M Latour, *Purdue University, West Lafayette, Indiana.*

Triglyceride (TG) is exported from the liver in the form of very low-density lipoproteins (VLDL). This study examined the effect of fasting on plasma lipids, specifically VLDL. Four horses aged 13.5 + 3.9 yr were fasted or fed mixed grass hay (2.1% fat DM) *ad libitum* for a 36 h period beginning at 0800. Each horse served as its own control with a 7 d interval between study periods. Blood samples were collected every 2 h and plasma isolated. A density < 1.006 g/mL plasma fraction containing VLDL (and potentially chylomicron lipoproteins in fed horses) was

separated from plasma by ultracentrifugation. Components of VLDL including TG, total cholesterol (TC), free cholesterol, phospholipid (PL), and protein (PRO) were quantified. Plasma TG, TC, glucose, and NEFA concentrations were also measured. Total VLDL concentration was calculated by summing TG, TC, PL, and PRO concentrations. Repeated measures analysis revealed that fasting had a significant ($P < 0.10$) effect on VLDL concentration over time. Compared with fed horses, mean VLDL concentration was higher in fasted horses at 16 h and means differed significantly ($P < 0.05$) by 36 h. However, individual variation was observed. Fasting induced significantly higher VLDL concentrations in only two of the four horses. The percentage of TG in VLDL increased significantly ($P < 0.10$) with time in fasted horses. Plasma NEFA concentrations were significantly higher ($P < 0.001$) in fasted versus fed horses with mean (SE) concentrations of 299.9 (19.9) $\mu\text{mol/L}$ and 46.4 (2.1) $\mu\text{mol/L}$, respectively. Plasma TG, TC, and glucose concentrations did not differ significantly between groups. Results indicate that lipid-rich VLDL particles accumulate in the circulation of fasted horses, either as a result of accelerated secretion or inhibited clearance. Further studies are required to determine why individual horses respond differently to fasting. Potential contributing factors include body composition, endocrine status, genetic predisposition, and stress tolerance.

Key Words: Fasting, Lipids, VLDL

867 Plasma glucose responses of growing horses to different concentrate feeds. A. C. St. Lawrence*¹, L. M. Lawrence¹, S. H. Hayes¹, and M. Adams², ¹*University of Kentucky, Lexington, KY,* ²*Cooperative Research Farms, Guelph, ON.*

Fourteen horses (9 mos) were used to determine the effects of two concentrate feeds on glucose response to a meal. Initially, all horses received

a diet consisting of a control concentrate (16.9% CP, 10.3% NDF, 3.1% fat, 1.41% Ca, 1.0% P, 519ppm Fe, 184ppm Zn, 66ppm Cu) at 65% of the DE required for moderate growth, and ad libitum access to alfalfa hay. Following a 10-d period, the horses were fasted overnight and blood samples were collected immediately prior to a meal (25% of daily meal, .9-1.2 kg) and at 30-min intervals for 5 h after the meal was offered (B1). After B1, horses were blocked by age and assigned to treatment groups. Group C (n=7; 308 kg) continued to receive the control concentrate and Group F (n=7, 309 kg) received an isocaloric concentrate (16.1% CP, 16.5% NDF, 5.1% fat, 1.59% Ca, .96% P, 417ppm Fe, 155ppm Zn, 59ppm Cu). After 21 d, horses were bled (B2) following the same procedure as B1 except that each group received their respective dietary treatments as the test meal. To determine long-term effects of receiving diet F, horses were maintained on their respective diets for another 21-d and a third bleed was conducted (B3). In B3 all horses received the control concentrate as the test meal. Effects of diet on plasma glucose were determined by comparing areas under the response curve (AUC) and peak glucose concentrations between groups. Mean ADG was .53 kg and did not differ between groups. Differences in AUC were not observed between groups in B1, B2, or B3 ($P > .05$). Peak glucose concentrations were similar between groups during B1 and B3 but were lower in Group F during B2 ($P < .05$). The dietary component responsible for the differences in peak glucose between Group F and Group C is not clear. Both dietary soluble carbohydrates and dietary Zn have been implicated in altering glucose concentrations. The relatively small differences in soluble carbohydrates between diets may partially explain why differences in AUC were not observed in B2.

Key Words: Horse, Plasma Glucose, Diet

868 Fecal phosphorus excretion in yearling horses fed typical diets with and without exogenous phytase. M.T.M. Hainze*, K. A. Condon, J. A. Rush, R.B. Muntifering, and C.A. McCall, *Auburn University, Auburn, AL 36849.*

Phosphorus (P) returned to the environment in animal manures may detrimentally affect soil and water resources. Solubility of P returned to soil determines its rate and extent of assimilation by plants, which in turn affects P runoff and transport. Fecal P excretion was characterized in eight yearling geldings fed four typical diets differing in ingredient composition, with and without exogenous phytase. The experimental design was a 4 X 4 Latin square with repeated measures in which horses were fed Coastal bermudagrass hay at a rate of 1.5% of BW daily plus sufficient 12% CP sweet feed, 12% CP pelleted concentrate, whole oats or alfalfa cubes to meet NRC (1989) requirements for DE and CP. Phytase status represented a within-unit repeated measures factor. Each experimental period consisted of a 10-d acclimation to dietary treatments, 2-d fecal sampling, 7-d acclimation to exogenous phytase and another 2-d fecal sampling, followed by a 7-d diet changeover between periods. Diets were fed twice daily, and water and plain salt were available for *ad libitum* consumption. Phytase was delivered orally via syringe at time of feeding. When not being fed, horses were maintained in a drylot. Fecal samples were collected by rectal grab and were composited on an individual animal basis. Diet DM digestibility and fecal DM output were calculated by reference to AIA concentrations in feed and fecal DM. Fecal samples were analyzed for concentrations of total P and water-extractable P, and insoluble P was calculated as the difference between total and water-extractable P concentrations. Fecal output of total P, water-extractable P and insoluble P differed ($P < .05$) among diets, and total P excretion across all diets tended to be lower ($P = 0.16$) when phytase was administered (12.3 vs 13.8 g/d). Fecal output of total P, water-extractable P and insoluble P was 8.4, 3.0 and 5.4 g/d; 10.1, 3.9 and 6.9 g/d; 14.9, 5.3 and 9.6 g/d; and 19.0, 7.9 and 11.1 g/d, respectively, for diets containing oats, alfalfa cubes, sweet feed and pellets. Results are interpreted to mean that typical diets for horses, formulated to meet DE and CP requirements, can be expected to differ markedly with respect to quantity and solubility of P returned to the environment in feces.

Key Words: Equine, Phosphorus, Phytase

869 Passage rate of ingesta in Standardbred race horses. J. VandenBrink and J. H. Burton*, *University of Guelph, Guelph, Ontario, Canada.*

A trial was conducted on six Standardbred horses in race training to investigate the effects of training stress on rate of ingesta passage. Three

horses were in their early phase of training (low intensity (LI): jogging 4 miles per day, six days per week); three horses were race trained in 2:05 (minutes per mile) or less (high intensity (HI)). Two markers were used simultaneously to estimate passage rate: Cr-mordanted bran fiber to follow particulate matter; CoEDTA as a fluid phase marker. Mordanted fiber was fed in pellet form in one meal and CoEDTA was administered as a drench. Total fecal collection took place over 72 h commencing 6 h after marker administration. A 10 percent subsample of feces from each time period was retained for analysis of dry matter, Cr and Co. Feces were pooled over 3 hour intervals from 6 to 36 h and 6 h intervals from 36 to 72 h. Cr and Co were analysed in feces using atomic absorption spectrometry. Average fecal dry matter from all horses was 20.5 percent. Average mean retention times (MRT) for particulate matter as determined from Cr data were 30.7 h and 33.3 h for HI and LI horses respectively. Fluid phase had significantly lower retention times with MRT of 23.3 h for HI and 18.8 h for LI. Results indicate that particulate material was retained about 50 percent longer than the fluid phase.

Key Words: Rate of pasage, Standardbred race horses, Cr-mordanted fiber CoEDTA

870 Effects of melatonin implants on plasma concentrations of leptin and body weight in obese pony mares. P.R. Buff*, C.D. Morrison, E.L. McFadin-Buff, and D.H. Keisler, *University of Missouri-Columbia.*

Our objectives were to determine if subcutaneous melatonin implants would alter the diurnal rhythm of leptin secretion and subsequently alter body weight in obese pony mares. Seven ovariectomized and eight intact pony mares (initial weight 273.6 ± 17.9 kg) were used. Four mares from each group were implanted with 144 mg melatonin (Regulin[®], Sanofi, Watford, UK) and the remaining mares received no implant. All mares were allowed *ad libitum* pasture. Beginning at 10:00 h and 17:00 h plasma samples were collected every 15 minutes for one hour. This sampling protocol was repeated weekly from 7 July 2000 until 7 October 2000. Body weights were taken weekly following the 10:00 h blood sample. Plasma samples were analyzed for leptin using a double antibody homologous radioimmunoassay validated for equine leptin in our laboratory. The mean concentration of leptin from each of the 4 plasma samples was used for statistical analysis. Separate analyses for leptin were performed for 10:00 h and 17:00 h sampling periods to determine treatment differences. No differences in plasma concentrations of leptin were detected between melatonin implanted and non-implanted mares for the 10:00 h sampling period ($P = 0.62$). A significant treatment by day effect was detected for the 17:00 h sampling period ($P = 0.0012$), but post-test comparisons of the means resulted in no differences between treatment groups. No differences in plasma leptin levels were detected between ovariectomized and intact mares ($P > 0.7$). In contrast, plasma concentrations of leptin differed between morning (10:00 h) and evening (17:00 h) samples 22.07 ± 1.7 vs. 28.24 ± 1.7 , respectively; $P < 0.0001$). Treatment with melatonin had no effect on body weight change ($P = 0.09$). From these data we conclude that neither melatonin implants nor ovariectomy influences plasma concentrations of leptin in pony mares. However, differences in plasma concentrations of leptin were detected between the 10:00 h and 17:00 h samples, indicating that melatonin may not influence the diurnal pattern of leptin secretion.

Key Words: Equine, Leptin, Melatonin

871 Determination of pregnancy outcome of mares grazed on a non-toxic endophyte-infected tall fescue. B. J. Rude*, B. A. Warren, D. J. Lang, and P. L. Ryan, *Mississippi State University.*

Tall fescue infected with *Neotyphodium coenophilaum* (E+) is known to be toxic to late-term pregnant mares. A non-toxic endophyte-infected fescue (NTE+) has been developed for grazing cattle, but safety for pregnant mares grazing this new fescue is unknown. The objectives of this study were to 1) evaluate the toxicity risks of pregnant mares grazing NTE+, and 2) determine the persistence of NTE+. Fifteen mares were allotted to graze one of three pasture treatments: 1) Endophyte-free fescue (E-); 2) NTE+; and 3) E+. Five mares grazed on each of the paddocks from March 1 until 3 weeks post-partum. Urine was collected weekly from mares for ergot alkaloid analysis. Placental membranes were submitted for histopathology. Results indicated that only mares

grazing E+ exhibited symptoms of fescue toxicity which included agalactia (n=4 of 5), compromised delivery (n=2), retained placenta (n=3), and one mare aborted at 301 days gestation. Additionally, mares exposed to E+ had longer (P < 0.05) gestation (353 d) compared to those grazing NTE+ and E- (333 and 340 d, respectively). Mean urine ergot alkaloid content was greatest (P < 0.01) for E+ (38.5 ng/mg creatinine) compared with NTE+ and E- mares (5.9 and 3.4, ng/mg creatinine, respectively). Placental measurements showed increased (P < 0.03) thickening of the cervical aspect of the placenta in E+ (4.49 mm) compared with NTE+ and E- mares (1.58 and 1.57 mm, respectively). A difference (P < 0.05) was also seen for amnion thickness between E+ and NTE+ mares (2.37 vs. 1.0 mm, respectively). Pasture endophyte infestation rates were 2.3%, 63% and 91% in March and 1.5%, 92% and 91% in May for E-, NTE+ and E+ pastures, respectively. Of the infected tillers during May, 6% of the E- and NTE+ samples were positive for ergot alkaloids while 100% of the tillers in the E+ pasture were positive. Tall Fescue stands were 32 % for E-, 96 % for NTE+, and 95 % for E+ pastures in mid-March and 1 % (E-), 41 % (NTE+), and 27 % (E+) at the end of September, after a dry and hot summer (< 1 cm rainfall, 27 days > 37 C during July- September). Stand decline and survival in both NTE+ and E+ were related to soil type and landscape features. These findings suggest that NTE+ is a safe herbage for the grazing of late-term pregnant mares.

Key Words: Equine, Pregnancy, Non-toxic infected-fescue

872 Manipulation of the dopaminergic system affects prolactin but not LH secretion in anestrus and cycling mares. K. Bennett-Wimbush¹, B. Musolf², and D. Keisler³, ¹Ohio State University Agricultural Technical Institute, Wooster, Ohio, ²Cuyahoga Community College, Parma, Ohio, ³University of Missouri, Columbia, Missouri.

Previous research has shown that dopamine antagonists can hasten follicular growth and ovulation in transitional mares. The mechanism of action appears to be by modulation of prolactin and not FSH. However, the effect of dopamine antagonists on LH is unknown. The purpose of this study was to determine the effects of 2-bromo-ergocriptine (dopamine agonist) and perphenazine (dopamine antagonist) on prolactin and LH secretion during different reproductive stages. Six mares were used in a 3x3 Latin Square design experiment. Treatments included .375 mg/kg oral perphenazine (P), 0.08 mg/kg⁷⁵ 2-bromo-ergocriptine (B) intramuscularly (IM) or an equivalent volume of saline (S), IM. Each mare received all treatments once during anestrus, estrus and diestrus. Prior to treatment, each mare was fitted with an indwelling jugular catheter and pre-treatment blood samples were collected every 20 minutes for one hour, starting at time 0. After pre-treatment samples were collected, a single dose of either P, B or S was administered as described above. Blood samples were obtained every 20 minutes for 7 hours following treatment. Samples were analyzed for prolactin and LH via radioimmunoassays. Differences in mean prolactin (PRL), mean LH (LH), maximum prolactin (MAXPRL) and maximum LH (MAXLH) for cycle, treatment and cycle*treatment were tested using GLM. The relationship of prolactin and LH observed during this study parallels previously published works. Plasma PRL and MAXPRL were lower (p < .01) during anestrus (13.4 ± 7.3, 18.0 ± 9.0 ng/ml) when compared to concentrations observed during estrus (18.3 ± 9.8, 26.2 ± 13.1 ng/ml) or diestrus

(18.8 ± 9.3, 30.0 ± 14.1 ng/ml). As expected, plasma concentrations of LH and MAXLH were higher (p < .01) during estrus. Perphenazine treatment increased (p < .01) PRL and MAXPRL during all stages of the mares' cycles. PRL was 23.7 ± 9.3, 12.2 ± 5.6, 14.1 ± 7.0 ng/ml for P, B and S treatments respectively. Treatment with B did not significantly alter either PRL or MAXPRL when compared to the control (S). Similarly neither of the treatments had any effect on LH or MAXPRL. In conclusion, the dopaminergic system plays a key role in the regulation of pituitary prolactin secretion, but does not appear to regulate LH.

Key Words: Dopamine, Prolactin, LH

873 Temporal variables of the park walk and park trot of the Morgan Horse. M.C. Nicodemus^{*1}, K.M. Holt¹, and H.M. Clayton², ¹Mississippi State University, Mississippi State, MS/USA, ²McPhail Equine Performance Center, East Lansing, MI/USA.

During competition, two of the gaits performed by the Morgan Park Horse are the park walk and park trot. According to judging standards, the park trot is a definite 2-beat diagonal gait but the park walk can be either a 2 or 4-beat walk with both being snappy, collected, and cadenced. Distinguishing between these gaits can be difficult for the novice judge. Therefore, the objective was to clearly define the park walk and park trot. Frame-by-frame analysis was done on 5 Morgan Park Horses performing 4 strides of the park walk and park trot at Morgan Horse Nationals. The mean (SD) of the following stride variables were determined: stride duration, fore and hind stance durations, lateral and diagonal step intervals, and limb support phases. Both gaits demonstrated a diagonal footfall sequence (RH-LF-LH-RF) with short contact intervals between the hind and diagonal forelimb. In each park walk half-stride, the support sequence was: tripedal (2 hind and 1 fore), quadrupedal, tripedal (2 hind and 1 fore), and diagonal bipedal. In each park trot half-stride, the support sequence was: single hind, diagonal bipedal, single hind, and suspension. Both gaits demonstrated a diagonal footfall sequence with diagonal couplets. The park walk had walking support characteristics with trotting footfall characteristics, whereas the park trot was similar to the trot. The shorter stride duration, the lack of tripedal and quadrupedal support, and the inclusion of suspension in the park trot differentiate it from the park walk.

	Park Walk	Park Trot
Stride Duration (ms)	835 (60)*	673 (33)*
Fore Stance Duration (ms)	513 (14)*	316 (18)*
Hind Stance Duration (ms)	443 (22)*	232 (22)*
Lateral Step Interval (%)	50 (7)	51 (8)
Diagonal Step Interval (%)	4 (1)	6 (2)
Suspension (%)	NA	10 (2)
Hind Single Support (%)	NA	20 (4)
Diagonal Bipodal Support (%)	75 (1)	70 (3)
Tripodal Support (%)	20 (1)	NA
Quadrupedal Support (%)	5 (2)	NA

Table 1: Park walk and park trot temporal variables (mean, SD) with significant differences (P<0.05) between variables of the gaits indicated (*).

Key Words: Equine locomotion, Temporal variables, Morgan Horse

ASAS Nonruminant Nutrition: Growth Management and Sow Nutrition; Aquaculture

874 Effects of feed deprivation prior to slaughter on changes in body weight and stomach morphology of finishing pigs. C. M. Dodd*, D. L. Rader, J. D. Hancock, G. A. Kennedy, C. W. Starkey, C. L. Jones, and D. J. Lee, Kansas State University, Manhattan.

A total of 176 pigs were used to determine the effects of feed deprivation (none, 12 h, 24 h, and 48 h) prior to slaughter on changes in BW and stomach morphology of finishing pigs. The pigs were blocked by sex and weight and allotted to 16 pens with 11 pigs per pen. The pigs were fed a corn (mean particle size of 600 microns)-soybean meal-based diet (0.8% lysine, 0.6% Ca, and 0.5% P) for 36 d (from 92 kg until slaughter). The diet had 4% soybean oil, was fed in pelleted form, and was consumed on an ad libitum basis. For the feed deprivation treatments, feeders were removed from the pens. To end the experiment, the pigs were loaded onto a truck at 0000, shipped to a commercial meat pack-

ing plant, and killed at 0600. The pars esophagea of the stomachs were collected and scored on a scale of 0 to 3 (0 = none, 1 = slight, 2 = moderate, and 3 = severe) for keratinization and ulceration. The mean BW of all pigs at initiation of the feed deprivation treatments was 127 kg. At shipping (i.e., 48 h later), BW changes ranged from 1.5 to 5.4 kg as duration of feed deprivation was increased from none to 48 h (linear effect, P < 0.001). Also, hot carcass weight decreased as duration of feed deprivation was increased (linear effect, P < 0.04). Keratinization score increased from 0.44 to 1.77 as duration of feed deprivation was increased (cubic effect, P < 0.03). Ulceration score increased slightly (from 0.02 to 0.56) but the changes were negligible except for the 48 h treatment (cubic effect, P < 0.04). In conclusion, feed deprivation prior to shipping for slaughter decreased final BW and hot carcass weight. Also, keratinization of the pars esophagea increased as duration of feed deprivation was increased but changes in ulcer scores were minor.

Item	Hours of feed deprivation				SE
	None	12 h	24 h	48 h	
Shipping wt, kg	127.6	126.3	124.9	122.2	1.0
BW change, kg	1.5	-0.7	-2.7	-5.4	0.3
Carcass wt, kg	92.0	92.7	92.0	90.1	0.7
Stomach keratinization	0.44	1.29	1.35	1.77	0.10
Stomach ulceration	0.02	0.23	0.05	0.56	0.08

Key Words: Pig, Ulcer, Feed deprivation

875 Effects of induced stresses on productive performance and serum concentration of acute phase proteins in growing-finishing pig. C. Pineiro*¹, E. Lorenzo², A. Pineiro³, and G. G. Mateos⁴, ¹PigCHAMP Pro Europa, Spain, ²Proinserga S. A., Spain, ³Universidad de Zaragoza, Spain, ⁴Universidad Politecnica de Madrid, Spain.

The objective of the trial was to study the influence of two induced stressors (ambient temperature and stocking density) on serum levels of two acute-phase proteins (Pig-MAP and Haptoglobine) and productive performance of pigs. A total of 228 Landrace x Large White pigs of 60 ± 3 d of age and 18.2 ± 2.4 kg of weight were randomly distributed in three rooms (cold, control, and warm). There were three densities (1.25, 0.72, and 0.56 m² per pig) and two sexes (boars and females) and one replicate per each ambient temperature. The trial lasted 98 d. Feed intake and body weight were measured every 14 d and blood samples from two pigs per replicate were taken at random at the same time. Overall performance was excellent (ADG = 818 g and FC = 2.08) and no clinical signs of any disease were observed. At the end of the trial pigs stocked at 1.25 m² grew faster and had better feed conversion than pigs stocked at 0.72 or 0.56 m² (P < 0.05) but ambient temperature did not affect performance. Significant interactions were found among main effects. Pigs placed at 1.25 m² grew faster than pigs placed at 0.56 m² under cold (P < 0.05) but not under control or warm temperature. From 60 to 74 d females grew faster and had better feed conversion than boars (P < 0.05). Pig-MAP serum concentration in this period was greater in boars than in females (P = 0.06). From 116 to 158 d, growth rate of boars decreased with increased density (P < 0.01). Also boars had higher levels of Pig-Map than females (P = 0.06) but no differences among sexes were detected for Haptoglobine. In the same period, the levels of both marker proteins were the highest for overstocked pigs (P < 0.05). We conclude that environmental stresses might impair pig performance and that the concentrations of Pig-MAP and Haptoglobine can be used under these circumstances to detect losses in performance.

Key Words: Pigs, Environmental stressors, Biomarker proteins

876 Influence of slaughter weight on performance and carcass quality of fattening pigs. M. A. Latorre*¹, A. Fuentetaja², P. Medel¹, and G. G. Mateos¹, ¹Universidad Politecnica de Madrid, Spain, ²COPESE S.A. Segovia, Spain.

A total of 192 Pietrain*Large White x Landrace*Large White pigs of 75 kg of initial BW was used to study the influence of final slaughter weight (SW) on productive performance and carcass quality. There were six treatments arranged as a factorial 3x2 with three SW (115, 124, and 133 kg) and two sexes (castrated males and females). Each treatment was replicated four times and the experimental unit was formed by eight pigs penned together. All the animals received *ad libitum* a common diet based on cereals and soybean meal (2,415 kcal NE/kg and 0.70% total lys) throughout the test. No interactions were detected between SW and sex for any of the traits studied. At the end of the trial, pigs slaughtered at 115 kg grew faster and had better feed conversion than pigs slaughtered at 124 or 133 kg (843, 788, and 769 g/d; P<0.05, and 3.19, 3.24, and 3.48 g/g; P<0.01). Castrates ate more (2844 vs 2448 g/d; P<0.01), grew faster (848 vs 752 g/d; P<0.01), and had worse feed conversion (3.35 vs 3.26 g/g; P<0.05) than females. Carcass yield improved with increased SW (77.3, 77.7, and 78.6%, for 115, 124, and 133 kg SW, respectively; P<0.01). Also backfat and thickness of fat measured at the *Gluteus medius* muscle augmented with increased SW (22.1, 25.7, and 27.0 mm, and 15.3, 19.4, and 19.8 mm for 115, 124, and 133 kg, respectively; P<0.01). Castrated males had less carcass yield (77.4 vs 78.3%; P<0.01), were 23.7% fatter (P<0.01), and had 29.7% more fat at *Gluteus medius* (P<0.01) than females. The length of the carcass and the ham increased with SW (P<0.01) but sex did not influence any of these measurements. Increasing the slaughter weight of

both castrates and females up to 124 kg might help improve the carcass and meat quality of pigs destined to cured products.

Key Words: Carcass quality, Slaughter weight, Fattening pigs

877 Impact of daily energy intake on rate and composition of gain in pigs with high lean growth potential. J.F. Patience*¹, C.M. Nyachoti², R.T. Zijlstra¹, R.D. Boyd³, and J.L. Usry⁴, ¹Prairie Swine Centre, Inc., Saskatoon, SK, ²University of Manitoba, Winnipeg, MB, ³PIC USA, Franklin, KY, ⁴Heartland Lysine Inc, Chicago, IL.

While the response to changes in amino acid intake is becoming better understood, there is a paucity of information on energy effects on the modern pig. A total of 83 castrated male and 83 female pigs (PIC Camborough 15 X L65) were used to investigate the impact of declining daily energy intake on the rate, efficiency and composition of gain from 25 to 120 kg. Individually-housed pigs received a diet formulated to be non-limiting in amino acids, vitamins and minerals at 100, 93, 86, 79, or 72% of *ad libitum*. Pigs were killed at 25±2 kg (n=8 within sex) to provide baseline body composition and at 50±2 kg (n=3 within sex and treatment group), 75±2.5 kg (n=3), 100±2.5 kg (n=4) and 120±3 kg (n=5) to determine whole body protein, lipid, ash and water content. For each weight period until slaughter, rate of gain and feed intake were recorded; backfat and loin thickness were measured by real time ultrasound. A linear decline in ADG from 25 to 120 kg occurred as daily energy intake declined (P<0.05): 1.02 and 1.00; 0.94 and 0.90; 0.89 and 0.82; 0.78 and 0.73; 0.71 and 0.62 kg/d for males and females at 100, 93, 86, 79 and 72%, respectively. As daily energy intake declined from 8.8 (100%) to 6.4 (72%) Mcal DE/d in males and from 9.1 to 6.4 Mcal DE/d in females, total body protein at 120 kg increased from 15.0 to 17.4% of empty body weight in males and from 15.9 to 17.5% in females (P<0.05). Total body lipid declined from 27.5 to 20.7% in males and from 25.0 to 19.3% in females (P<0.05) while percent ash was unaffected (P>0.05). Empty stomach and intestine weights increased and then decreased in a quadratic (P<0.05) fashion as daily energy intake declined. Definition of body composition as influenced by energy intake is essential to the use of factorial models in estimating nutrient requirements of pigs.

Key Words: Pig, Energy, Carcass

878 Effect of high temperature and energy intake on energy utilization in growing pigs. L. Le Bellego*, J. van Milgen, and J. Noblet, INRA, St Gilles, France.

Eight blocks of five barrow littermates were used to study the effect of ME supply at thermoneutrality (23C; TN; four blocks) and under heat stress (30C; HS; four blocks) on composition of BW gain. Relative to *ad libitum* intake (100) at each temperature, ME levels were 100, 90, 80 and 70 % for TN pigs and 100, 91, 85 and 77 % for HS pigs. Feeding levels were adjusted daily according to BW. Animals were fed a corn, wheat, and soybean meal based diet providing 0.95 g of standardized digestible lysine per MJ NE. One littermate per block was slaughtered at the beginning of the experiment (24 kg BW) to measure initial body composition; the four remaining littermates were affected to the four ME levels. Pigs were penned individually and slaughtered at 65 kg. Gain of nutrients and energy were calculated according to the comparative slaughter technique. Data were analyzed according to a covariance model including the effects of block, temperature, ME intake and interactions. At the TN-100 ME intake (32.2 MJ/d), daily gains of empty BW, protein, lipid and energy were 1021, 166, 259 g and 16.4 MJ, respectively. At 26 MJ/d ME intake, (corresponding to HS-100 and TN-80), daily gains of empty BW, protein and energy were higher (P<0.05) in TN (901 g, 151 g and 13.14 MJ, respectively) than in HS (876 g, 143 g and 12.75 MJ, respectively). Daily lipid gain was similar at both temperatures (190 g). At 22 MJ/d ME intake, corresponding to TN-70 and HS-85), daily gains of empty BW and protein were higher (P<0.05) in HS (795 and 139 g) than in TN (755 and 124 g), whereas daily gains of lipid and energy were lower in HS (141 g and 10.61 MJ) than in TN (169 g and 11.01 MJ). These results demonstrate that the partitioning of energy between protein and lipid deposition in growing pigs is affected by both ambient temperature and feeding level. At similar ME intakes, protein gain is reduced directly by heat stress in *ad libitum* pigs while a severe man-imposed feed restriction at thermoneutrality affects protein gain more than the combination of a man- and temperature imposed feed restriction.

Key Words: Growing Pig, Temperature, Protein Gain

879 Compensatory feed intake and growth in pigs. J. van Milgen*¹ and J. Noblet¹, ¹INRA, St-Gilles, France.

Growing pigs may face temporary challenges, such as disease or seasonal heat stress that may be overcome later. The objective of this study was to determine the extent to which growing pigs may recover from a period of feed restriction. Eleven groups of two littermate barrows were used. At 35 kg, pigs were moved to individual pens and adapted to the experimental conditions for 4 d. One animal of each litter (A) had ad libitum access to feed throughout the experiment. Its littermate (R) received 60% of the anticipated voluntary feed intake for six d followed by 12 d ad libitum access to feed. This cycle of feed restriction and re-feeding was repeated three times (starting at approximately 40, 60 and 80 kg BW). Feed intake and feed refusals were determined daily whereas BW was determined at the beginning and the end of the experiment (after an overnight fast) and after every change in feeding level. After the third period, animals were slaughtered. During the restriction periods, feed intake averaged 1.66 and 2.90 kg/d for groups R and A, respectively. During the re-feeding periods, feed intake was equivalent for both groups during the first two periods (average 2.95 kg/d) but was considerably higher for group R during the third period (3.86 vs 3.27 kg/d). For the complete experiment (35 to 100 kg), average feed intake was significantly higher for group A (2.90 kg/d) than for group R (2.70 kg/d) but average daily gain was not different between groups (1.08 kg/d). Periods of feed restriction and re-feeding caused considerable variation in gut fill for group R and biased the calculated growth rates. These (average) growth rates for respectively R and A were 0.22 and 1.18 kg/d during the restriction periods, and 1.51 and 1.11 kg/d during the re-feeding periods. Due to the increased feed intake in the last period, animals in group R had greater gut fill and tended to have lower carcass weights (79.9 vs 82.5 kg). There was little difference in carcass composition between treatments. These results indicate that (partial) compensatory growth exists in fast growing pigs, but compensatory feed intake may only be effective in the later stages of growth.

Key Words: Pigs, Compensatory Growth, Compensatory Feed Intake

880 Effects of soybean meal from different sources on sow and litter performance during gestation and lactation. H. K. Kim*¹, H. S. Kim¹, Y. H. Park¹, I. S. Shin², H. S. Lee², and K. Y. Whang¹, ¹Korea University, ²American Soybean Association/Korea.

An experiment was conducted to study effects of the differently originated-soybean meals during gestation and lactation periods on sow and litter performance. One hundred and twenty crossbred multiparous sows (Yorkshire Landrace) were assigned to three dietary treatments and fed corn-soybean meal based diets containing the U.S. dehulled (USDH), Brazil, and India soybean meal (SBM) as a major protein source. Diets were formulated to meet the nutrient requirements (NRC, 1998). Sows were fed different diets during gestation, lactation and from weaning to estrus, according to physiological status. The ADG, ADFI and G/F did not differ ($P > .05$) among treatments in gestation period. In lactating period, ADFI, backfat change, and days of weaning-to-estrus were not different but body weight change was significantly different ($P < .10$). Number of born alive in the USDH treatment was higher ($P < .10$) than that in Brazil treatment. Also, litter weight at birth of the USDH treatment was greater ($P < .05$) than that of Brazil treatment. Litter weaning weights of the USDH, Brazil and India treatments were 56.10 kg, 52.93 kg and 54.42 kg, respectively. This experiment concludes that feeding a diet with the USDH to sows exhibits a better litter performance than feeding diets with Brazil or India SBM.

Item	USDHSBM	Brazil SBM	India SBM	SEM
Gestation				
ADFI, kg	3.07	3.06	3.08	0.005
ADG, kg	0.47	0.44	0.44	0.025
Gain/Feed, g/kg	153	152	147	9.452
Lactation				
ADFI, kg	5.02	4.90	4.93	0.125
Body weight change, kg	-22.18 ^a	-15.29 ^b	-15.53 ^{ab}	2.090
Backfat change, cm	-0.38	-0.24	-0.28	0.046
Re-estrus interval, d	6.08	5.79	5.86	0.334
Litter performance				
Number of born alive	10.03 ^a	8.72 ^b	9.38 ^{ab}	0.346
Birth weight, kg	14.33 ^c	11.86 ^d	13.02 ^{cd}	0.503
Weaning weight, kg	56.10	52.93	54.42	1.352

^{a, b} $P < .10$; ^{c, d} $P < .05$

Key Words: Sows, Soybean meal, Litter performance

881 Effects of dietary supplementation with mannan oligosaccharides on sow and litter performance in a commercial production system. P. R. O'Quinn*¹, D. W. Funderburke¹, and G. W. Tibbetts², ¹Cape Fear Consulting, LLC, Warsaw, NC, ²Alltech, Inc., Nicholasville, KY.

This trial was conducted to evaluate the effects of dietary addition of mannan oligosaccharides (MOS) on sow and litter performance in a commercial production system. The MOS used in this trial (Bio-Mos) was supplied by Alltech, Inc. Sows ($n = 509$ and 517 for MOS and control sows, respectively) were of PIC genetics with average parity and initial BW of 3.26 and 264 kg, respectively, and were fed MOS starting a minimum of three wk prior to farrowing (0.20% inclusion of Bio-Mos) and throughout the 21-d lactation period (0.10% inclusion of Bio-Mos). Diets were analyzed for mycotoxins: values for aflatoxin, T-2, fumonisin, DON, and ochratoxin were low and similar between diets. Sows were weighed upon entry into the farrowing house (d 112 of gestation) and at weaning, and litters were weighed at processing (approximately 30 h after birth) and at weaning. Addition of MOS did not affect ($P > 0.05$) sow weight loss, number born alive, stillborns, or mummified fetuses. Addition of MOS resulted in heavier ($P < 0.05$) litter birth and weaning weights. Average pig weight gain for the MOS and control pigs was 4.11 and 3.79 kg, respectively. Pre-weaning mortality was reduced ($P < 0.01$) by feeding MOS to the sows (9.09 vs 11.27% for the MOS and control sows, respectively). Concentrations of IgA, IgG, and IgM in pre-nursing colostrum samples ($n = 48$ and 42 for MOS and control sows, respectively) were increased by dietary addition of MOS. Concentrations of IgG showed the greatest response ($P = 0.007$; 5,853 vs 4,842 mg/dL) to MOS supplementation, followed by IgM ($P = 0.03$; 273 vs 241 mg/dL), and IgA ($P = 0.06$; 1,178 vs 1,097 mg/dL). The changes in composition of the pre-nursing colostrum samples may help explain the observed improvements in pig growth performance. In summary, the reduction in pre-weaning mortality coupled with the improvements in litter growth performance indicates that additions of mannan oligosaccharides may be beneficial in commercial sow herds.

Key Words: Sow, Litter, Mannan oligosaccharides

882 Effect of dietary levels of soluble and insoluble fiber on energy digestibility and nitrogen balance in gestating sows. J.A. Renteria*, L.J. Johnston, and G.C. Shurson, University of Minnesota, St Paul MN.

Gestating sows (12 nulliparous, NULL; 12 multiparous, MULT) were used to assess the effect of different levels of soluble (S) and insoluble (IS) fiber on energy digestibility and nitrogen balance. Experimental diets included: Control (C) - corn-soybean meal diet (1.59% S, 7.67% IS); High Soluble Fiber (HS) - corn-soybean meal-oat bran (34% oat bran, 3.19% S, 8.95% IS); High Insoluble Fiber (HIS) - corn-soybean meal-wheat straw (12% wheat straw, 1.46% S, 15.36% IS); and High Soluble/High Insoluble (HS/IS) - corn-soybean meal-sugar beet pulp (16% beet pulp, 3.20% S, 15.31% IS). Sows were randomly assigned to diets, and fed to meet their energy requirements according to the NRC model (1998), assuming 10 pigs per litter and 40 kg gestation gain. Total collections of feces and urine were conducted in 5-d periods at wk 5, 10, and 14 of gestation. Greater apparent digestibility of dietary gross energy (87.1 vs 86.2%; $P < .02$; SE = .34) and nitrogen (85.7 vs 83.1%; $P < .01$; SE = .63) was observed for MULT vs NULL females throughout gestation. There were no interactions between parity group and dietary treatments for the evaluated response criteria. Apparent digestibility of dietary energy throughout the evaluated periods was lowest for females fed HIS (82.7%) vs C (87.9%), HS (89.3%), and HS/IS (86.8%; $P < .01$; SE = .48). Apparent digestibility of dietary nitrogen throughout the evaluated periods was similar between C and HS (86.1 and 86.2%) but greater ($P < .05$; SE = .90) than HIS and HS/IS (82.8 and 82.8%). Apparent nitrogen digestibility but not energy declined ($P < .05$) as time on diet and gestation progressed. In conclusion, multiparous sows demonstrated a greater ability to digest fibrous diets than nulliparous females. Inclusion of insoluble fiber in diets for gestating sows depresses energy digestibility and nitrogen balance, but elevated levels of dietary soluble fiber do not influence these variables. Knowledge of specific dietary fiber components is necessary to accurately predict effects of dietary fiber on digestibility.

Key Words: Sow, Fiber, Digestibility

883 **Reproduction, conceptus growth and plasma reduced folates in sows in response to dietary supplementation with oxidized and reduced sources of folic acid.** A. F. Harper^{*1}, J. W. Knight¹, E. Kokue², Y. Toride³, and J. L. Usry⁴, ¹Virginia Polytechnic Institute & State University, ²Tokyo University of Agriculture & Technology, ³Ajinomoto Company Incorporated, ⁴Ajinomoto Heartland Incorporated.

The study was conducted to determine the response of sows to oxidized and reduced forms of supplemental folic acid in the diet. Yorkshire x Landrace gilts were mated and fed a standard corn-soy diet (0.57 ppm folacin) with no supplemental folic acid. On d 105 of gestation gilts were randomly assigned to one of four dietary treatments for the remainder of the study. Treatments included a diet with no supplemental folate (control), a diet with 2.1 ppm added folate from an oxidized monoglutamate form (MG), a diet with 2.1 ppm added folate from N5-Formyl-5,6,7,8-THFA (leucovorin) and a diet with 2.1 ppm added folate from a commercial organic source (Ajinomoto-PG). Breeding-gestation diets were fed at a rate of 1.8 kg/sow/d and lactation diets were fed ad libitum. Plasma samples for HPLC determination of reduced plasma folates were collected on d 105, at weaning, at mating and when the sows were sacrificed on d 45 after mating for the second parity. There were 19, 18, 18 and 22 sows for the control, MG, leucovorin and Ajinomoto-PG treatments, respectively. Supplementing folacin just prior to farrowing and during lactation had no effect on measures of sow and litter performance during the first parity ($P > 0.18$). Live fetuses at d 45 of gestation in parity 2 were 10.06, 12.23, 10.87, and 11.07 for the control, MG, leucovorin and Ajinomoto-PG treatments, respectively. Due to variability in the data the litter size advantage with added folate was not significant (added folates vs. control, $P = 0.15$). Fetal survival and placental size and protein content was generally unaffected by folate treatment. Reduced folates in sow plasma were 13.50, 13.58, 22.50, and 17.79 nM at weaning and 12.55, 19.29, 18.96, and 21.88 nM at mating for the control, MG, leucovorin and Ajinomoto-PG treatments, respectively, with the leucovorin treatment elevated significantly above the controls at weaning ($P < 0.05$) and the Ajinomoto-PG treatment greater than controls at mating ($P < 0.05$). In this study folate supplementation from oxidized or reduced sources of folate did not impact sow reproductive performance but the reduced sources (leucovorin and Ajinomoto-PG) appeared to increase circulating reduced folates at mating and weaning time.

Key Words: Sows, Folic acid, Reproduction

884 **Evaluation of pea ingredients for rainbow trout (*Oncorhynchus mykiss*) diets.** D.L. Thiessen^{*1}, G.L. Campbell¹, and P.D. Adelizi², ¹University of Saskatchewan, Saskatoon, SK, Canada, ²Whitewater Trout Co., Whitewater, CA, USA.

While nutrient digestibility data is available for whole peas (*Pisum sativum*), data is lacking for further processed pea ingredients in rainbow trout diets. Air classification of dehulled peas produces a concentrated product (50% CP, 20% starch) that may be beneficial in the continuing search for alternative feedstuffs suitable for salmonid diets. This study was undertaken to determine the effects of various milling and heat treatments on the nutrient and energy digestibility of pea ingredients in rainbow trout. The apparent crude protein, amino acid, acid ether extract, starch, energy and dry matter digestibility of raw/whole pea, raw/dehulled pea, extruded/dehulled pea (145°C, 620-740 psi) and autoclaved air-classified pea protein (125°C, 15 min) was determined. The ADC of each test ingredient was determined on diets in which 30% of a reference diet was replaced by each test ingredient. Experimental diets contained 1% acid insoluble ash as the indicator. Eighteen fish (300±15 g) per tank were adapted to the test diet (n=4) for 7 days with subsequent fecal collection for 4 days using a settling column. Results indicate that raw/whole pea protein was highly digestible (90.0%) in rainbow trout but the large starch component was essentially indigestible (14.3%), resulting in an ingredient with poor digestible energy (54.6%). Removal of the fibre-rich hull through dehulling had no significant effect on digestibility of raw peas ($P > 0.05$). Extrusion of dehulled peas increased crude protein, starch and energy digestibility (93.5, 100.7 and 78.4%, respectively; $P < 0.05$). Subsequent air classification and autoclaving of dehulled peas proved to be beneficial by concentrating the protein and removing the majority of the indigestible starch, ultimately producing an ingredient with exceptional protein and energy digestibility (94.6 and 87.0%, respectively; $P < 0.05$). Based on digestibility it was concluded that autoclaved air-classified pea protein is an appropriate aquafeed ingredient for salmonid fish.

Key Words: Peas, Digestibility, Rainbow trout

885 **Apparent nutrient digestibility of fishmeal and feather meal diets for juvenile Pacific white shrimp (*Litopenaeus vannamei*).** Zongjia Cheng^{*1}, K.C. Behnke², and W.G. Dominy³, ¹University of Idaho, Hagerman, ID, ²Kansas State University, Manhattan, KS, ³The Oceanic Institute, Waimanalo, HI.

A 35.8% CP shrimp diet containing 24.5% fishmeal (LT-94) was modified by substituting regular hydrolyzed feather meal (FTM), or a high digestible feather meal (FTMHD), at 33.3, 66.7 and 100% replacement for fishmeal on w/w basis. Additionally, synthetic amino acids (AA), L-lysine and DL-methionine, were added to FTM and FTMHD so that their total lysine and methionine contents were the same as in fishmeal. The modified FTM diets also were formulated to replace fishmeal at 33.3, 66.7 and 100% levels on w/w basis. Thirteen diets (including a fishmeal control diet) were fed to 936 shrimp (initial BW 1.77.75 g) for 20 d. Three aquaria/diet and 24 shrimp/aquarium were used. Cr₂O₃ was used as an inert marker. Results showed that the apparent protein digestibility (APD) for fishmeal diet was higher than FTM or FTMHD based diets for shrimp ($P < .05$). However, the apparent dry matter digestibility (ADMD) and apparent fat digestibility (AFD) of fishmeal were lower than those FTM or FTMHD based diets ($P < .05$). The APD, ADMD and AFD were 81.6%, 70.9% and 93.5%, respectively, for shrimp fed fishmeal diet. For those FTM or FTMHD diets, APDs varied from 51.7% for shrimp fed FTMHD plus AA replacing 100% fishmeal diet to 77.3% for shrimp fed FTMHD plus AA replacing 33.3% fishmeal diet ($P < .05$). ADMDs ranged from 63.7% for shrimp fed FTMHD plus AA replacing 100% fishmeal diet to 75.7% for shrimp fed FTMHD replacing 100% fishmeal diet ($P < .05$). AFDs ranged from 93.5% for shrimp fed FTMHD plus AA replacing 100% fishmeal diet to 96.8% for shrimp fed FTMHD replacing 66.7% fishmeal diet ($P < .05$).

Key Words: Apparent nutrient digestibility, shrimp, Fishmeal and Feather meal

886 **Apparent nutrient digestibility of fishmeal and poultry by-product meal diets for juvenile Pacific white shrimp (*Litopenaeus vannamei*).** Zongjia Cheng^{*1}, K.C. Behnke², and W.G. Dominy³, ¹University of Idaho, Hagerman, ID, ²Kansas State University, Manhattan, KS, ³The Oceanic Institute, Waimanalo, HI.

A 35.5% CP shrimp diet containing 24.5% fishmeal (FM, LT-94) was modified by replacing FM with two types of poultry by-product meal (regular, PBM; and petfood grade, PBMPG) at 33.3, 66.7 and 100% on w/w basis. Additionally, the PBM and PBMPG were defatted and fish oil was added back so that their oil contents were the same as the original samples. These modified meals were also used to replace FM at 33.3, 66.7 and 100% levels on w/w basis. Thirteen diets (including FM control diet) were fed to 936 shrimp of average BW 1.77.75 g for 20 d. Shrimp were stocked into 3 aquaria per treatment (diet) and 24 shrimp per aquarium. During the first 3 d, shrimp consumed their respective test diets, feces were collected on the 4th d of the Exp. Cr₂O₃ was used as an inert marker. Results showed that the apparent dry matter digestibility (ADMD), apparent protein digestibility (APD) and apparent fat digestibility (AFD) were 76.9%, 86.1%, and 94.9%, respectively, for shrimp fed FM diet. For the PBM diets, ADMDs ranged from 63.4% for shrimp fed PBM replacing 100% FM diet to 78.6% for shrimp fed defatted PBMPG replacing 66.7% FM diet ($P < .05$), APDs varied from 66.7% for shrimp fed PBM replacing 100% FM diet to 84.2% for shrimp fed defatted PBMPG replacing 66.7% FM diet ($P < .05$), and AFDs ranged from 94.8% for shrimp fed PBMPG replacing 33.3% FM diet to 97.2% for shrimp fed defatted PBMPG replacing 100% FM diet ($P > .05$).

Key Words: Apparent nutrient digestibility, Shrimp, Fishmeal and poultry by-product meal

887 Identification of factors that cause genotype by environment interactions between dairy production systems. N.R. Zwald* and K.A. Weigel, *University of Wisconsin - Madison*.

The objective of this study was to describe the production systems in countries that participate in international dairy sire evaluations, and to identify factors that cause variation in progeny performance between herds. Test day data from first lactation Holstein cows in Australia, Austria, Belgium, Canada, Czech, Estonia, Finland, Germany, Hungary, Ireland, Israel, Italy, the Netherlands, New Zealand, South Africa, Switzerland, and USA were used. These data included 233,673 herds, 16,403,413 cows, and 131,907,373 test day records from cows calving between 1/1/90 and 12/31/97. Herds were grouped into 5 quintiles for each of 11 management variables and 2 climate variables. Heritability of milk yield was calculated within each quintile of each variable, and genetic correlations between quintiles were computed. Genetic correlations less than unity and significant differences in heritability between quintiles were found for peak yield, average sire PTA milk, temperature, fat to protein ratio, days to peak yield, within-herd standard deviation of milk yield, and percent North American Holstein genes. Currently, differences in production systems between countries are considered in international sire evaluations. However, variation in management or climate within countries is ignored. We have identified some of the factors that cause genotype by environment interactions between individual herds. This research shows that it is more reasonable to define traits based on the production conditions in each herd, as opposed to defining traits based on country borders. Grouping herds on these variables should create international sire evaluations that are more appropriate for genetic selection decisions on individual farms, because each sire will receive a PTA for each unique production system. In addition, the number of unique production systems will likely be less than the number of countries, and this will lead to greater accuracy of parameter estimates and a more efficient international evaluation system.

Key Words: Genotype by Environment, International Evaluations

888 Genotype by environment interaction for milk production traits in Guernsey cattle. W.F. Fikse*¹, R. Rekaya², and K.A. Weigel², ¹*Interbull Centre, Uppsala, Sweden*, ²*University of Wisconsin, Madison*.

International genetic evaluations that use national genetic evaluation results as input need to acknowledge country borders. The current model for international evaluation treats each country as genetically separate trait, and assumes milk production to be similar within country, but different between countries. The use of unprocessed cow performance records does not require such restriction, and allows for other statistical models to consider genotype by environment interaction. First lactation records from 45,000 Guernsey cows in four countries (Australia, Canada, United States and South Africa) were used to detect and describe genotype by environment interaction for milk production traits. Five statistical models were considered: a) single trait across country, b) single trait across country with heterogeneous residual variance, c) multiple trait across country, d) multiple-trait herd cluster model, and e) reaction norm model. For the herd cluster model, herds were clustered into groups based on information on herd management, genetic composition and climate. Reaction norms describe the phenotype expressed by a genotype as a function of the environment, and are modelled by random regression on descriptors of production environment. The same variables to describe production environment were used in the herd cluster and reaction norm model. Gibbs sampling was used to make inferences about the parameters of interest, and models were compared based on Bayes factors and deviance information criterion. Posterior mean and mode for heritability for the single trait model was .33, and ranged from .25 to .40 for models b) and c). Genetic correlations between countries estimated with model c) were generally high (.87 - .92). Heritabilities obtained from the reaction norm model differed substantially depending on descriptive variable, and ranged from .10 to .50 in 'poor' and 'good' environments. Genetic correlations between extreme environments were between .80 and unity depending on environment descriptor. Both Bayes

factors and deviance information criterion indicated that country borders do not effectively distinct between production environments.

Key Words: International Genetic Evaluation, Guernsey, Lactation Records

889 Evidence for genotype by environment interaction in production traits of US Holsteins under grazing versus confinement. J. F. Kearney*¹, M. M. Schutz¹, P. J. Boettcher², and K. A. Weigel³, ¹*Purdue University*, ²*University of Guelph*, ³*University of Wisconsin*.

Grazing, as a form of low input dairying, has increased in popularity. However grazing herds tend to forego conventional US Artificial Insemination (AI) sires, in favor of sires proven in other grazing countries or novel breeds. The objective of this study was to investigate possible genotype by environment interaction in grazing versus confinement herds in the US. Grazing herds (GH) were defined as utilizing grazing for at least 6 months each year and were enrolled in Dairy Herd Improvement. A total of 414 GH in 14 states contributed 101,872 records of 24,451 AI-sired Holstein cows, calving from 1990 to 1999. Control herds (CH) were confinement herds of similar size in the same states. The CH had 144,863 records from 61,273 AI-sired Holstein cows. The performance of daughters in GH and CH was examined using linear regression of mature equivalent milk (MEM), fat (MEF) and, protein (MEP) yield on the 11-00 USDA Predicted Transmitting Abilities (PTA) of their sires for those traits. The model also included the fixed effects of herd, year-season, and age-parity. For GH or CH, regression coefficients were estimated for all records, for four random subsets, and for four subsets based on quartiles of herd average MEM. Average MEM was greater for CH (10,008 kg) versus GH (8602 kg). For GH, the coefficients of regression of MEM, MEF, and MEP on PTA were significantly less ($P < 0.01$) than 1 (the expected value), except for MEM and MEP in the highest quartile ($P > 0.2$) and MEP in one of the random subsets. In CH, MEF, and MEP were significantly less ($P < 0.01$) than 1, only for the lowest quartile. MEM was less ($P < 0.05$) than 1 in two of the random subsets and in the lowest and second highest quartiles. MEM, MEF, and MEP were all greater ($P < 0.01$) than 1 for the highest quartile. Results suggest that performance of cows in GH may not be predicted adequately by current US recording and genetic evaluation systems, but relationships may be due to both production level and management system.

Key Words: Genetics, Grazing, Genotype by environment interaction

890 Effects of genotype-by-environment interactions in conventional versus pasture-based dairies. P. J. Boettcher*^{1,2}, J. Fatehi¹, and M. M. Schutz³, ¹*University of Guelph, Canada*, ²*ANAFI, Cremona, Italy*, ³*Purdue University, West Lafayette, IN*.

The objective of this study was to evaluate effects of genotype-by-environmental interaction (GxE) on dairy traits among herds in Canada that practice intensive rotational grazing versus conventional methods that rely on stored feeds. The basic approach taken was to estimate the genetic correlation between phenotypes for a given trait expressed under the two different environmental conditions. Based on responses to questionnaires, 22 herds were selected for the grazing group. These herds were required to intensively graze their cattle for at least six months per year, during which pasture provided at least 70% of the forage in the cows' diets. In addition, herds were required to be enrolled in DHI and to record pedigree data. All herds were in either Nova Scotia or Ontario. The control (conventional) group consisted of 34 large free-stall operations. Data were DHI records from 1990 and later and consisted of 6749 lactations from 2817 cows in the grazing herds and 29,371 lactations from 12,774 cows in the control herds. Per cow production was greater in the conventionally managed herds (9947 kg milk) than in the grazing herds (9300 kg). Genetic correlations were estimated by multiple trait REML and a model that included fixed effects of age-parity and herd-year-season-parity classes and random effects of animal, permanent environment, and residual. Effects of GxE were minor, with genetic correlations of near 0.90 or greater. Genetic correlation was lowest for fat yield (0.88 with SE = 0.04). Genetic correlations for milk and protein

were 0.93 and 0.94, respectively. Heritabilities were greater for the yield traits in the conventionally managed herds, averaging about 0.37 versus 0.32 in the grazing herds. An equivalent analysis was performed for the conformation traits Frame and Capacity, Mammary System, and Feet and Legs, using data from approximately 12,000 cows. Genetic correlations for Mammary System (1.00) and Feet and legs (0.97) were near unity. The estimate for Frame and Capacity was slightly lower (0.90). These results demonstrate that effects of GxE are small between the two types of management systems analyzed and that sires will rank similarly when progeny tested in the two environments.

Key Words: Genotype-by-Environmental Interaction, Intensive Grazing

891 Method to establish average relationships among Holstein bull populations over time. B. Auvray^{*1}, G.R. Wiggans², F. Miglior³, and N. Gengler^{1,4}, ¹*Gembloux Agricultural University, Belgium*, ²*Agricultural Research Service, USDA, Beltsville, MD*, ³*Canadian Dairy Network, Guelph, Canada*, ⁴*National Fund for Scientific Research, Brussels, Belgium*.

Average relationship coefficients between groups of animals were calculated by repeating three calculation steps until convergence was reached. The first step was a stratified sampling of pedigrees. Second, relationships between animals in the sample were calculated, using the group relationships computed in a previous round for unknown parent relationships. Third, results were accumulated by group. Average relationship coefficients calculated in this way can be used for such purposes as to better understand the structure of a population, to more accurately calculate inbreeding coefficients, and to assign unknown parent groups using clustering methods. This method was applied to the pedigree data for the worldwide Holstein sire population. The data was derived from Interbull and North American pedigree databases. Groups were defined by year of birth, sex, and country. Average relationships between US and Canadian bulls increased across time from 0.02 in 1960 to 0.12 in 1999. The increase was continuous except for a plateau in 1992, followed by a slight decrease until 1995 when the trend to increase resumed. Average relationships across time comparing Canadian with European bulls and US with European bulls are quite similar. They increased from about 0 in 1963 to 0.10 in 1999. After a peak of 0.05 in 1966, the relationships dropped to 0.03 in 1976 before starting to increase again. For bulls born in 1996 in the US, Canada, and Germany (representing a typical European country), the average relationships were: 0.116 (Canada-Canada), 0.112 (Canada-USA), 0.1 (Canada-Germany), 0.101 (USA-USA), 0.101 (USA-Germany) and 0.084 (Germany-Germany). These results demonstrate the recent dramatic increase in relationships and inbreeding in the worldwide Holstein population, and show the power of this method of calculating relationship coefficients.

Key Words: Relationship, Holstein, Bull population

892 Possible global scale for ranking dairy bulls by blending national rankings. R.L. Powell^{*} and P.M. VanRaden, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD*.

International genetic evaluations are computed routinely for dairy bulls using multi-trait across country evaluation methods. Separate rankings are provided on the scales of member countries, but a global scale also could be useful in marketing across countries and for use by non-member countries. National units of expression were removed by dividing the evaluation on each scale by the country's standard deviation. These standardized evaluations were weighted by each country's fraction of global cow numbers and blended into a global evaluation. That approach is predicated on interest in breeding for a world market, but other weights may be considered. Fractions of global cow numbers were estimated by the proportions from each country of all daughters of evaluated bulls in the international evaluation. For the Holstein evaluation, countries with the largest cow numbers included the United States (18%), Germany (15%), France (13%), New Zealand (10%), and the Netherlands (9%). Twenty one other countries accounted for 35%. Standard deviation of the global scale can be set to a constant and a fixed genetic base can be imposed simply by setting the mean of evaluations equal to the previous mean. Conversion formulas for the global scale to and from each country scale may be needed. Correlations of bull evaluations

on the separate country scales for protein averaged .976 within birth year. Correlations of the country scales with the global scale ranged from .955 to .995 with a mean of .988. Even with high correlations, there was reranking. The use of a global scale could ease the transition to an evaluation of data grouped and modeled by herd management and climate variables instead of national borders. Separate regional, country, or cluster rankings would still be needed to provide selection tools adapted to local conditions. Global evaluations would allow both participants and non-participants to select for a global market.

Key Words: genetic evaluation, international rankings, dairy cattle

893 Estimation of genetic correlations between countries and prediction of sire breeding values using individual animal performance records. K. A. Weigel^{*1}, R. Rekaya¹, N. R. Zwald¹, and W. F. Fikse², ¹*University of Wisconsin, Madison*, ²*Interbull Centre, Uppsala, Sweden*.

Our objective was to estimate genetic correlations between milk production in different countries and to predict international sire breeding values using individual animal performance records. Data included first lactation records of 16,403,413 Holstein cows that calved between January 1, 1990 and December 31, 1997 in 233,673 herds in Australia, Austria, Belgium, Canada, Czech Republic, Estonia, Finland, Germany, Hungary, Ireland, Israel, Italy, Netherlands, New Zealand, South Africa, Switzerland, and USA. Milk yield in each country was considered as a different trait. Genetic parameters and sire breeding values were estimated using a multiple-trait sire model that included the effects of sire, herd-year-season of calving, age at calving, milking frequency, and heterosis class. Heritabilities ranged from 0.25 in Finland to 0.34 in Israel. Genetic correlations between countries ranged from 0.77 between Estonia and both Ireland and Israel to 0.96 between Belgium and Netherlands and between New Zealand and both Australia and Ireland. Some correlations differed markedly from values that are now used in international sire evaluations. In particular, correlations of 0.94 or greater were found between Australia, Ireland, and New Zealand, all countries that rely heavily on rotational grazing. Correlations of 0.92 or greater were found between Belgium, Canada, Italy, Netherlands, and USA. Correlations between the intensively managed countries and the rotational grazing countries ranged from 0.82 to 0.88. Examination of the top 1% of bulls (N=665) on each country scale revealed that 556 bulls were selected in one country only, 861 were selected in at least five countries, 461 in at least 10 countries, and 107 in all 17 countries.

Key Words: genetic evaluation, dairy sires, international

894 Simultaneous estimation of genetic correlations for milk yield among a large number of Holstein populations. H. Jorjani^{*}, *Interbull, Department of Animal Breeding and Genetics, Swedish University of Agricultural Sciences*.

Estimation of genetic correlations among all 26 Holstein populations participating in Interbull's international genetic evaluation of AI bulls is hampered by the large number of country combinations (325), the large number of bulls in the correlation estimation (>110000) and the low number of common bulls with estimated breeding values (proofs) in more than one country (about 110 country combinations had less than 20 common bulls). These problems have led to the current practice of estimating genetic correlations among smaller well-connected groups of countries rather than among all 26 countries in one single evaluation, which in its turn leads to the prolongation of the turn around cycle, multiple estimates of some country combinations, and more importantly the need for bending the resulting covariance matrix. Therefore, to find a subset of data that facilitates a simultaneous and speedy estimation process for all 26 populations without introducing bias is desirable. To achieve this, new methods of selecting well-connected subsets of data have been examined. These involved selection of data based on the bulls' number of proofs and two different measures of connectedness, namely, weighted and effective number of proofs, which are based on number and distribution of bulls' daughters across countries. These alternatives were used in combination with time edits, that is selecting the subset from all available bulls or only bulls born in the last 17 years, i.e. as is the current practice for estimation of breeding values. Results indicated that the estimated genetic correlations are very sensitive to even small

changes in the number of common bulls, probably because few bulls can potentially provide a significant amount of genetic links. Subsets selected based on different measures of connectedness resulted in higher average genetic correlations and larger number of correlations that are biologically sensible (>0.75). Time edit resulted in increased estimates among countries that share young bulls and decreased estimates among countries that rely heavily on the importation of old proven bulls.

Key Words: Connectedness, data subset, time edit

895 Alternative strategies for estimation of country sire variance in international evaluations of dairy bulls. F. Miglior^{*1}, P. G. Sullivan², and B. J. VanDoormaal¹, ¹Canadian Dairy Network, ²CGIL, University of Guelph, Guelph, ON, Canada.

Three alternatives were compared to estimate sire variances in Interbull evaluations. Sire variance estimates are used in international evaluations of dairy bulls to account for different scales of proof expression in each country. Currently these variances are estimated in MACE using all bulls that have daughters in at least 10 herds by country. This group includes locally sampled bulls and imported bulls first sampled abroad. Sire variances are estimated using approximate Mendelian sampling terms (MS), which have an assumed expected value of 0 for all bulls. While average MS of bulls sampled locally may be close to zero, MS of imported bulls tends to be positive, as only top proven bulls are imported in any country. A total of 59,657 Holstein bulls from ten major dairy countries were evaluated with MACE, based on genetic evaluation files and genetic correlation estimates used by Interbull in the November 2000 routine run. Sire variances were estimated for each country using MS of either: a) all bulls (the current Interbull procedure); b) only bulls sampled locally; or c) only bulls born in the last five years (1992-96). The last group included mostly first crop locally sampled bulls. Variances were estimated by birth year and across all years for each of the three data sets for milk, fat and protein yield. For protein yield, sire variances estimated using only locally sampled bulls ranged from -1% to -12% lower than variance estimated using all bulls. Sire variances estimated using bulls born in the last 5 years ranged from -8% to +9% of the variance estimated using all bulls. In order to quantify the impact of different estimates of sire variability on international evaluations, changes in bull rankings and bull proofs were also compared. A simulation study is required to identify the most accurate strategy to estimate sire variance in a MACE evaluation.

Key Words: International evaluations, sire variance estimation

896 Variance of effects of lactation stage within herd by herd yield. N. Gengler^{*1,2} and G.R. Wiggans³, ¹Gemblox Agricultural University, Belgium, ²National Fund for Scientific Research, Brussels, Belgium, ³Agricultural Research Service, USDA, Beltsville, MD.

First-lactation test-day yields from New York, Wisconsin, and California herds with low (<7257 kg), medium (9072 to 9525 kg), and high (>11,340 kg) annual milk yields were adjusted additively for age and lactation stage. Two random regression models with third-order Legendre polynomials for permanent environmental and genetic effects were used. The second model also included a random effect with the same polynomial regressions for 2-yr intervals within herd (herd-stage effect). Mean adjusted test-day milk yields were 35.4 kg (75,838 test days in 9108 lactations) for high-yield herds, 28.8 kg (74,845 test days in 8887 lactations) for medium-yield herds, and 25.6 kg (71,996 test days in 8490 lactations) for low-yield herds. Although estimated phenotypic variances also declined with herd yield, those variances were surprisingly similar for medium- and low-yield herds. Herd-stage effect on phenotypic variance was negligible. Heritabilities for high- and medium-yield herds initially decreased and then gradually increased across lactation stages. Maximum heritability (0.33, high-yield herds; 0.30, medium-yield herds) was reached from 200 to 300 d in milk. Heritabilities were lower for low-yield herds but increased rapidly (maximum of 0.22 at lactation end). Introduction of a herd-stage effect eliminated the heritability decrease in early lactation for high- and medium-yield herds and reduced the increase in late lactation for low-yield herds. Heritabilities generally were lower with inclusion of a herd-stage effect, which indicated that variances for this effect were partly considered genetic in the

less complete model. Herd-stage variances relative to phenotypic variance were highest at the beginning (12%) and end of lactation (7%) for medium-yield herds. Herd yield and stage had a large effect on variance size and change across lactation stages during first lactation and should be considered when accounting for heterogeneous variances in genetic evaluations.

Key Words: Heterogeneous variance, Test-day model

897 Lactation curves of milk production traits of Italian Water Buffaloes estimated by a mixed linear model. N.P.P. Macciotta^{*1}, G. Catillo², G. Pulina¹, A. Carretta², and A. Cappio-Borlino¹, ¹Dipartimento di Scienze Zootecniche, universit di Sassari, Italia, ²Istituto Sperimentale per la Zootecnia, Roma.

Aim of the work is the estimation of lactation curves of milk production traits of Italian water Buffaloes pertaining to different age classes and seasons of calving. Data were 4064 Test Day records of milk production traits (milk yield, fat and protein percentages) recorded on 534 Italian buffalo cows during the years 1986-1999 in a farm of the Istituto Sperimentale per la Zootecnia. Animals were grouped according to 6 level of age at calving and to 4 levels of season of calving. Data were analysed with a mixed linear model that included test date, age at calving, season of calving and stage of lactation as fixed effects plus a random animal effect associated with each lactation. Average lactation curves were estimated by solving for the effects of stage of lactation nested within age at calving and season of calving. Milk yield lactation curves of animals of different ages resulted clearly separated till 20 weeks from parturition, with buffaloes of 4-5 years having the highest curve. Peak yield occurred at around the 6th week of lactation in all age classes; buffalo cows of 2-3 years of age showed the highest persistency which, however, is markedly lower than in dairy cattle. No effect of age at calving could be observed for fat and protein percentages. Season of calving affected milk yield only in the first phase of lactation, with the lowest production levels for summer calvings; no effect could be observed on fat and protein contents. Actually, the inclusion of a TD effect accounted for much of the seasonal variation normally observed among buffalo cows calving in different seasons, in agreement with previous results obtained in dairy cattle. Average correlations among TD measures within animal or repeatabilities, calculated on the basis of the variance component associated to the random animal effect and of the residual variance, were 0.59, 0.31 and 0.36 for milk yield, fat and protein percentages respectively.

Key Words: Buffalo, Milk Production Traits, Lactation Curves

898 Heritability estimates for birth weight of exotic dairy breeds in Nigeria. O.T.F. Abanikanda^{*1}, O. Olutogun², A.O. Leigh¹, M. Orunmuyi³, and O.Y. Apena¹, ¹Department of Zoology, Lagos State University, Nigeria, ²Department of Animal Science, University of Ibadan, Nigeria, ³Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria.

Genetic parameter estimates for traits are specific for a particular breed in a specified environment. Weight of calves at birth has been established to be the first and quickest index of some of the performance traits of cattle. The correlation of birth weight to other performance traits as weaning weight, milk yield and survivability has been well documented. This research aim at computing the heritability of birth weight of Holstein and Jersey breeds, calved and bred in the medium to high trypanosomiasis-risk zone of Southern Nigeria. The 475 Holstein calves used in this analysis are from 13 sires and the 39 Jersey calves are from 4 sires. Factors studied included year of birth, season of birth, sex of calf, parity of calf as fixed effects and the sire effect was used as random effect. The SPSS (1996) software was used for both the analysis of variance and the variance component estimation. The General Linear Model (GLM) for variance component estimation using the ANOVA method was used to estimate the variance components. The paternal half sib method of Henderson ($h^2 = 4\sigma_s^2 / \sigma_s^2 + \sigma_w^2$) was used to compute heritability for both breeds. In the Holstein calves, all factors except the parity were highly significant ($P < 0.01$), while only the sire effect was significant ($P < 0.05$) in the Jersey calves. The mean birth weight for the Holstein and Jersey calves are 32.59 ± 0.24 kg and 21.15 ± 0.44 kg respectively. In the Holstein breed, the males were 1.67kg

heavier than females and the highest birth weight was recorded in the late wet season. This seasonal variation in birth weight was due to the amount of precipitation recorded in those seasons as reflected in the availability of forage for the pregnant dams, which are rarely given supplemental feeds. and the h^2 for Holstein and Jersey was 0.49 ± 0.26 and 0.54 ± 0.35 respectively. The moderate to high heritability estimate obtained in these analyses implies that these breeds of animal could be maintained as purebred, despite the prevailing inimical environmental conditions.

Source	DF (Holstein)	MS (Holstein)	DF (Jersey)	MS (Jersey)
Year of birth	15	90.87**	6	8.27ns
Season of birth	3	163.02**	3	10.82ns
Sex of Calf	1	213.87**	1	1.42ns
Parity of dam	7	24.66ns	5	11.42ns
Sire of calf	12	67.99**	3	22.55*
Error	436	23.36	19	7.10

** = $P < 0.01$; * = $P < 0.05$; ns = $P > 0.05$

Key Words: Heritability, Birthweight, Trypanosomiasis

ASAS/ADSA Extension Education: Beef

899 Performance comparisons between mature cows categorized by weight and frame score combinations that are enrolled in a cow herd performance testing program. S.R. McPeake*, W.T. Wallace, and L. Keaton, *University of Arkansas Cooperative Extension Service.*

Data from (n = 164) cows and their calves were analyzed to compare differences in performance levels between cows categorized by weight and frame score combinations. General linear model procedures were used to generate least squares means for dependent variables. Weight categories (WT) for the cows were small (< 500 kg), moderate (500 to 544 kg), large (545 to 590 kg) and extra large (> 590 kg). Frame scores (FS) represented included 4, 5, 6, and 7. Cow size (CS) included all possible combinations of WT and FS that were available in the data set. WT was significant ($P < 0.05$) for adjusted 205 day weight (WWT), cow efficiency (CE) and FS. CS was significant ($P < 0.05$) for WWT, CE, and body condition score of cows (BC). No significant differences were found between CS for muscle score (MS) of calves. As WT increased, WWT increased but CE decreased. Within WT, cows with larger frame scores generally had higher WWT with the exception of extra large cows. Within each WT, CE increased with FS with the exception of the extra large cows. Cow frame size and weight may need to be considered when matching cows to production environments.

Key Words: Beef cattle, Cow size, Efficiency

900 Designing and implementing a quality assured, source-verified feeder calf sale program. T. Nennich^a, C. R. Dahlen^b, C. M. Zehnder^b, L. R. Miller^b, G. C. Lamb^c, D. Kampmeier^d, and A. DiCostanzo^{*b}, ^a*Clearwater County Extension, Bagley, MN*, ^b*University of Minnesota, St. Paul*, ^c*North Central Research and Outreach Center, Grand Rapids*, ^d*Central Livestock Association, South St. Paul.*

A producer-driven quality assured, source verified feeder calf sale program was initiated to enhance marketing options for producers, to create a repeat-buyer feeder calf outlet, and to increase profitability and growth of the Minnesota beef industry. Several marketing agencies were interviewed according to marketing criteria producers wished to follow. A marketing agency was chosen and charged to set and promote sale dates, provide transportation, facilities and personnel to form outcome groups of cattle of similar color, frame and muscling, and to sell outcome lots within a regular sale date. Producers agreed to follow specific beef quality assurance (MBQA) procedures, and to background and process calves for disease prevention. Cattle were immunized against viral and bacterial diseases at weaning time and boosted against viral diseases 15 d before the sale. On the sale date, an experienced sale observer gathered cattle description, weight and price data on all lots sold. A regression equation was fitted to determine factors that had a significant ($P < .05$) effect on sale price. Color, muscling, sex, and health status were factors that influenced sale price in addition to weight and lot size. Steer MBQA lots sold better than other vaccinated steers or steers under no vaccination protocol 56% or 75% of the time for a total advantage of \$3 or \$13/head, respectively. Heifer MBQA lots sold better than other vaccinated heifers or heifers under no vaccination protocol 41% or 76% of the time for a total advantage of \$1.86 or \$12.21/head, respectively. Compared to single source lots, when a producer contributed up to 12 steers or heifers to a larger lot, the advantage of selling in larger lots

was \$.068/kg. Producers and the marketing agency were satisfied with the experience and have made a commitment to continue this endeavor.

Key Words: Quality Assurance, Cattle, Sales

901 Mississippi farm to feedlot program: carcass performance. W.B. McKinley, A.R. Williams*, J.N. Myers, A.G. Gardner, and E. Ward, *Mississippi State University, Starkville, MS.*

The objectives of the Mississippi Farm to Feedlot program are to evaluate production and carcass information of steers produced in Mississippi, and to provide educational information regarding retained ownership as a marketing alternative. Seven years (1993-1998) of data were collected and the effects of year of feeding (YR) and sire breed (SB) on carcass performance were evaluated. Sire breeds were classified into three breed groups, British Breeds (BB), European breeds (EB), and American breeds (AB). Carcass performance response variables included steer hot carcass weight (HCWT), back fat thickness (BF), ribeye area (REA), marbling score (MS), quality grade (QG), and yield grade (YG). Both YR and SB significantly influenced carcass performance. HCWT was greatest ($p < .05$) for steers in YR 5 and 6 (352 and 344 kg, respectively) compared to all other years. Steers in YR 1 had greater ($p < .01$) BF (1.52 cm) than steers in all other years. REA was larger for steers in YR 3 and 7 (87.09 and 87.07 cm²) and least for steers in YR 1 (79.04 cm², $p < .01$). MS was the highest in YR 5 at 396 and the lowest in YR 1 at 362 ($p < .01$). QG mirrored MS with steers in YR 5 having the highest QG and those in YR 1 the lowest QG (17.89 and 17.24, respectively, $p < .01$). YG was greatest in YR 7 at 2.86 and the lowest in YR 4 at 2.57 ($p < .01$). SB did not influence ($p > .05$) HCWT. However, SB did significantly influence all other carcass traits. BB and AB sired steers had greater ($p < .01$) BF (1.34 and 1.31 cm, respectively) than EB sired steers (0.97 cm). EB sired steers had larger REA (88.14 cm², $p < .05$) than BB and AB sired steers (83.39 and 82.16 cm², respectively). MS and QG were greater ($p < .01$) for BB sired steers (403 and 18.07, respectively). YG was lowest ($p < .01$) for EB sired steers at 2.4 compared to 2.76 and 2.89 for AB and BB sired steers, respectively. Overall, QG improved as the program progressed. BB sired steers exhibited the highest QG, while EB sired steers had the lowest YG.

Key Words: Cattle, Feedlot, Carcass

902 On farm/ranch HACCP - Is it time? W.J. Means*, *University of Wyoming, Laramie, WY/USA.*

Based on review of available literature, the objective was to determine if HACCP (Hazard Analysis Critical Control Points) could be efficaciously applied to livestock production systems to reduce the prevalence of *Escherichia coli* O157:H7 in beef products. HACCP involves prevention of hazards affecting food safety from production to consumption. Currently, HACCP application in relation to control of pathogenic food-borne bacteria extends to processing plants, retail outlets, and restaurants - not to the farm or ranch. Steps necessary for food borne illness (FBI) to occur include pathogen contamination of the food, abuse of the food, improper cooking, and consumption of the food in question by a susceptible individual. Measures that break the sequence of events, thus deterring FBI, may be considered critical control points (CCP's). Reducing the number of pathogens entering a food/meat processing facility in/on livestock could further decrease the pathogen load of finished raw or cooked product. However, prevalence of *E. coli* O157:H7 in individual animals/herds as well as factors affecting shedding of the organism

has received limited study. Seven reports indicate *E. coli* O157:H7 is present in 0.28 to 11.6% of dairy cattle with a herd incidence of 8.3 to 75%. Two studies indicate *E. coli* O157:H7 is present in 0.33 to 13.4% of feedlot cattle and can be found in 10% of feedlots tested. Factors that may be associated with prevalence of *E. coli* O157:H7 include age of animal, herd biosecurity, feeding regimen, manure handling practices, weaning, and fasting. It is clear that single-time-point sampling of beef and dairy herds is an inadequate method to determine *E. coli* O157:H7 prevalence and that more research is needed to describe the true animal/herd prevalence. Since management practices that can actively reduce carriage and shedding of *E. coli* O157:H7 are not clearly defined, it is unrealistic to apply HACCP principles to cattle production systems at this time. Continued research to identify on-farm/ranch CCP's is needed to decrease the pathogen load of cattle entering processing plants.

Key Words: HACCP, *E. coli* O157:H7, cattle

903 A bioeconomic model of the broiler chicken supply chain - simulation for extension. M. J. Zuidhof^{*1}, R. J. Hudson², T. Joro², and J. J. R. Feddes², ¹*Alberta Agriculture, Food and Rural Development*, ²*University of Alberta*.

A dynamic, deterministic bioeconomic model of the broiler supply chain has been developed with the objective of assisting the poultry industry with complex decisions. Because of biological variability and complex industry structure it is often difficult to optimize decisions, which may be defined as decisions that yield maximum economic benefit to the supply chain. The model spans five sectors of the broiler supply chain: feed, hatching egg production, hatchery, broiler production, and processing. Biological productivity is based on the genetic potential of each strain of bird used in the model. The model operates on a daily time step, and accrues production and associated costs daily. The model simulates daily hatchery, feed, and processing cycles. The length of the broiler cycle is determined by the length of time required to produce chickens for specific processing objectives, which can be set in the user interface of the model. In the broiler sector, production costs are accrued until the time of processing, after which costs are held constant. Prior to the onset of lay in the breeders, actual costs of chick production are undefined, so the model draws on a user supplied chick price. After 250 d of simulation, the model uses simulated chick cost, which drops with increasing breeder age as costs are spread over larger chick numbers. The cost reported on the last day of simulation represents the predicted costs if breeders are kept for the entire production cycle. The model is set to simulate 66 wk of production, the standard broiler breeder cycle length in Canada. Costs are reported in formats that are meaningful to each sector of the supply chain, and as the total cost per kg of meat produced by the supply chain. This is useful for analyses of the effects of specific supply chain management decisions, such as the choice of genetic strain, on costs at the level of each sector. This is important because although a decision may be optimal for the supply chain as a whole, it may not be optimal for all participants in the supply chain.

Key Words: bioeconomic model, supply chain, chicken

904 Profitability analysis model for assessing the relationship between feeder frame scores, feed efficiency and carcass merit. K.C. Olson^{*}, V.L. Pierce, R.L. Larson, E.P. Berg, and C.L. Loenzen, *University of Missouri*.

Problem Cow calf producers are facing a changing beef marketing system. To that end, their interest in animal performance beyond the point of weaning is gaining with tremendous speed. However, the ability of cow calf producers to identify characteristics of early life animal performance which later impact feed efficiency, health, and carcass quality and yield are limited.

Objective To determine the economic relationship between USDA frame scores, weaning weight and early post weaning health on feedlot performance and carcass grade and yield.

Data and Methods

Data from the Missouri Premier Beef Marketing program is used in the study. Complete data collected from 699 calves in the Premier beef program include USDA feeder frame score, weaning weight, feeding efficiency, and carcass yield and quality. A general backpropagation-estimated feedforward artificial neural network is developed to explain the relationships between the stages of the animals life in these systems. This model is contrasted to an OLS regression attempting to explain

the same relationship. Model parameters are then used to identify economic relationships between early life performance, frame scores, feed efficiency and USDA carcass merit values. Multi-variate distributions are assigned to model stochastic variables to assess the risk and reward trade-offs in the final analysis.

Conclusion Economic trade-offs are presented which demonstrate the ability and likelihood that a cow calf producer can project feed efficiency and carcass merit from feeder frame scores and weaning weight and early post weaning health and feeding efficiency. The list below shows how a group of 156 head of steers animals is tracked economically; 65 percent choice or better, average carcass value of 847 dollars, average animal cost to feeder of 529 dollars, average available to feeder 322 dollars, maximum available to feeder per head 544 dollars, minimum available to feeder 113 dollars, 92 of the 156 were profitable to the feeder leaving 19.35 dollars per head at the feedyard. This data is used with feeder grades to identify those animals that were profitable in the feedlot and determine associated relationships for use in the predictive model.

Key Words: Feeder Calves, Economics, Carcass

905 The use of early post weaning performance and quality data of feeder calves in determining the best marketing method for cow calf producers. R.L. Larson, V.L. Pierce^{*}, and K.C. Olson, *University of Missouri*.

Problem Cow calf producers are facing a changing beef marketing system. Producers have increased access to early post weaning performance and quality information on their calves. However, a system that allows producers to measure the economic trade-offs between these data and available marketing systems is largely unavailable in a user-friendly computerized decision tool.

Objective To evaluate the economic trade-offs between early post weaning performance and quality characteristics of feeder calves and develop a farm specific decision tool which allows producers to evaluate various marketing methods given likely feeding and carcass merit performance of their calves.

Data and Methods

Data from the Missouri Premier Beef Marketing program is used. This program coordinates a group of cow-calf operations with the objective of gaining market power by producing uniform, quality animals that can be traced from birth through slaughter. With this program, for example, 20 producers with 50 calves each can market 1000 calves in sorted potload size lots with similar health, genetics and management programs. Feedlot performance and carcass data can be fed back through the production chain to each cow-calf member producer to assist in making production and management decisions. Animals are commingled and developed during a short 45-90 day backgrounding period. Complete data collected from 699 calves in the Premier beef program include serial USDA feeder muscling scores, USDA frame score, weaning weight, feeding efficiency, and carcass yield and quality. An ordinary least squares multi-variate model is developed to explain the relationships between the stages of the animals life in these systems. Spreadsheet add-on tool At Risk is used with enterprise budgets to assess the impact of variable distributions on decisions regarding various marketing methods including commodity market sale, full and partial retained ownership.

Conclusion Producers can use this spreadsheet tool, based on actual calf performance data, to evaluate the likely performance of their feeder calves and thus determine the risks and reward trade-offs under various marketing scenarios.

Key Words: Feeder Calves, Economics, Decision Tool

906 The A.I.M. Program (Allied Inputs and Marketing): A Producer Cooperative that Reduces Production Costs and Increases Market Value of Calves. L. H. Anderson^{*}, J. T. Johns, K. D. Bullock, and W. R. Burris, *University of Kentucky*.

Small and medium-sized producers face tremendous production and marketing disadvantages due to the lack of economics of size. Approximately 85% of beef cattle operations in Kentucky consist of 50 cows or less. The University of Kentucky Beef Extension Team has developed a new program that encourages producers to form a production and marketing alliance. The focus of the A.I.M. (Allied Inputs and Marketing) program is to improve profitability of beef cattle production by allowing small and medium size beef producers to utilize economies of scale.

Two production alliances have been developed in Kentucky. One alliance has both a purchasing and marketing function and consists of 22 producers who own approximately 1500 cows (average size = 68 cows; range = 10-200). The second alliance is a purchasing alliance only and consists of 107 producers who own 6237 cows (average size = 58 cows, range 7-400 cows). Each member agrees to purchase only through the alliance. The alliance then requests bids from local vendors on products such as vaccines, dewormer, growth implants, mineral, preconditioning feed, semen, and estrus synchronization products like melengestrol acetate. Savings on these products have been tremendous. Purchase price of vaccines (respiratory disease complex, clostridial diseases, and reproductive diseases) have been reduced an average of 23.25% (range = 22-26%). Costs of deworming products decreased 24.0% while savings on growth promotants average 18%. Similarly, savings on mineral averaged 24.7%. Over the past two years, production costs decreased \$12-20 per cow due to the purchasing programs in these alliances. The cooperative marketing of the alliance cattle has increased net return \$28-37 per cow over the last two years in one alliance. Thus, return per cow has increased for \$40-57 per cow due to the production and marketing cooperative. Based on these results, participation in these alliances has increased profitability and sustainability of small and medium-sized beef producers.

Key Words: Beef, Extension, Marketing

907 Cow College: Implementation of an Intense, 9-day Educational Opportunity for Beef Producers in Kentucky. L. H. Anderson*, W. R. Buriss, K. D. Bullock, J. C. Henning, P. B. Scharko, D. W. Shepherd, J. D. Anderson, and C. W. Absher, *University of Kentucky*.

A renewed interest in profitability and an increase in nontraditional clientele have increased the need for more educational opportunities for producers. An instructional program was developed by the Kentucky Beef Integrated Beef Management Team to educate producers in all aspects of beef production. Cow College consists of 5 separate training sessions conducted from July to November. The first session discusses economics of the beef industry. Lecture material includes farm goal setting, record keeping, marketing, and the future market. Laboratory exercises discuss case studies in which producers are asked to make financial decisions using economic tools such as backgrounding spreadsheets. Producers also gain experience in the feedlot/packer industry by participating in the Packer-Feeder game. The second session focuses on beef cattle nutrition. Lectures regarding beef cattle nutrients, characterization of feedstuffs, planning both forage and nutritional programs and mineral supplementation. Laboratory sessions include body condition scoring, ration balancing and reading mineral and feed tags. The third session discusses herd health and cattle handling. Herd health programs, implanting, dehorning and castration are discussed and demonstrated. The basics of cattle handling are also taught. The fourth session focuses on breeding management. The basics of genetics, crossbreeding programs, bull selection, heifer selection, female reproduction, male reproduction and reproductive management are taught. Laboratory sessions provide opportunities to learn AI, pregnancy diagnosis, pelvic area measurements, BSE, and bull selection. The final session discusses end product. Students learn to calculate yield and quality grade of both live cattle and carcasses. Carcasses are fabricated and students also participate in a taste panel focusing on palatability of select versus choice beef. Since July of 1999, 32 producers have been trained. Herd sizes of these producers ranged from 10 to 900 cows and backgrounding operations ranged from 50 to 5000 calves. Most producers have indicated that Cow College was an outstanding program and session evaluations have averaged 8.6 (1-10, 1 being lowest).

Key Words: Beef, Extension, Education

908 Mississippi farm to feedlot: feedlot performance. W.B. McKinley, A.R. Williams*, J.N. Myers, A.G. Gardner, and E. Ward, *Mississippi State University, Starkville, MS*.

The objectives of the Mississippi Farm to Feedlot program are to evaluate production and carcass information of steers produced in Mississippi, and to provide educational information regarding retained ownership as a marketing alternative. Seven years (1993-1998) of data were collected and the effects of year of feeding (YR) and sire breed (SB) on feedlot performance were evaluated. Sire breeds were classified into three breed groups, British Breeds (BB), European breeds (EB), and American breeds (AB). Feedlot performance response variables included steer

final weight (FWT), final gain (FGN), final average daily gain (FADG), and final age at harvest (FAGE). Both YR and SB significantly influenced feedlot performance. FWT was greatest for steers in YR 5 at 548 kg ($p < .01$), intermediate for steers in YR 4 and 6, and the least in YR 1, 2, 3, and 7. FAGE was also greatest ($p < .01$) in YR 5, with steers averaging 532 d at harvest, whereas steers in YR 1 were significantly younger at harvest (460 d). FGN was highest ($p < .05$) in YR 4 and 6 (261 and 269 kg, respectively), and lowest in YR 3 and 7 (233 and 232 kg, respectively). FADG was highest ($p < .01$) for YR 4 and 6 (1.44 and 1.45 kg/d, respectively) and lowest for YR 2 and 5 (1.29 and 1.28 kg/d, respectively). FWT and FGN were not influenced ($p > .05$) by SB. However, SB did influence FADG with BB and EB sired steers exhibiting daily gains of 1.40 and 1.37 kg/d compared to 1.34 kg/d for AB sired steers ($p < .05$). SB also influenced FAGE with BB sired steers the oldest at harvest at 499 d, AB sired steers at 494 d, and EB sired steers were the youngest at 467 d ($p < .01$). Year of feeding significantly affected feedlot performance in all variables measured. There was a tendency for steers to be younger and lighter at harvest in the first three years of the program. SB significantly influenced FADG and FAGE. BB and EB sired steers had significantly higher FADG compared with AB sired steers.

Key Words: Cattle, Feedlot, Performance

909 Establishing a catfish off-flavor control program in Georgia. G. J. Burtle*¹, G. W. Lewis², M. Fowler³, and T. Cummings³, ¹*Animal & Dairy Science, University of Georgia, Tifton, GA 31793*, ²*Warnell School of Forest Resources, University of Georgia, Athens, GA 30602*, ³*Cooperative Extension Service, University of Georgia, Louisville, GA 30434*.

In 2000, more than 545,500 kg of channel catfish under production in Jefferson county, Georgia were off-flavor. Individual catfish ponds were sampled to determine the extent of the off-flavor problem. Ponds that had off-flavor catfish were not harvestable due to refusal of processing plants to purchase the off-flavor catfish. Twentytwo ponds ranging in size from 1.25 to 5.0 ha were found to have a few hundred to over 5,000 colonies per mL as blue-green algal species known to cause off-flavor in catfish. A leading cause of off-flavor in catfish, *Oscillatoria perornata*, was present in 40.9% of the ponds from 184 to 8,820 colonies per mL. That species produces methylisoborneol, the leading cause of catfish off-flavor. Control options included chemical treatments with copper containing herbicides, algae-eating fish, and special label extension for diuron herbicides. An emergency label extension under Section 18 of the Federal Insecticide, Fungicide and Rodenticide Act was applied for and was granted by USEPA. The label extension directly affected catfish valued at \$472,000 and indirectly affected 13 ponds containing catfish valued at \$682,000. A system of alternating copper containing chemicals with diuron herbicide was recommended for the catfish producers using county meetings, newsletter articles, and news releases.

Key Words: Catfish, Off-flavor, Herbicides

910 Effectiveness of a volunteer association in conducting 4-H/youth extension activities. M.J. Wylie*, M.J. Miller, R.B. Housel, L.H. Pribek, and R.J. Antoniewicz, *University of Wisconsin, Madison, WI*.

A volunteer association can be highly effective in the planning and conduction of 4-H/youth extension activities. Yearly district and state events are critical to most extension youth programs yet the organizational details required can often overwhelm state specialists and county staff in this era of dwindling staff and increasing program needs. One way to effectively manage yearly events such as conferences and competitions is to empower volunteers. The Wisconsin 4-H Horse Association is the current organization that has evolved and expanded since its beginnings in 1965. Its purpose is "to plan, promote and execute educational programs in the area of horse science for Wisconsin youth and their leaders". It works in conjunction with county 4-H agents and state specialists and can serve as a model for other species and/or discipline volunteer associations. All currently enrolled 4-H Horse and Pony or Horseless Horse adult leaders are members and each of the six districts elects three directors. The association sponsors the following state events: clinics, hunt and dressage show, gymkhana, horse expo (educational events and show classes), and an annual leaders conference. A volunteer leader (all project areas) survey recently conducted in Wisconsin revealed the top reasons a person continues as a volunteer are: personal satisfaction, desire to serve community, friendships,

children still in program, and interest in specific project. A pre-survey of association directors revealed common reasons for volunteering were: enjoy working with youth and horses and a desire to contribute back to a program, which benefited them. Some of the challenges listed included trying to keep program costs minimal for leaders and youth, personal expense when attending association activities, and improving communi-

cation. Overall, directors consider the association to be highly effective in conducting 4-H/youth horse extension activities. These volunteers are examples of extremely dedicated individuals with a common interest - to offer youth quality educational programs.

Key Words: Volunteer association, 4-H/youth, Extension horse activities

ASAS/ADSA Forages and Pastures: Grazing

911 Evaluation of calf and forage production in rotational stocking systems for spring- and fall-calving beef cows. N. A. Janovick*¹ and J. R. Russell¹, ¹Iowa State University.

To evaluate two forage management systems, 24 spring-calving Angus-cross cows with calves were rotationally stocked in four 8.1-ha smooth bromegrass-orchardgrass-birdsfoot trefoil (SB-OG-BFT) pastures on April 22, 1999, and April 26, 2000. In a hay harvest (HH) system, spring-calving cows with calves grazed 2.03 ha for 58 d. Forage from the remaining 6.07 ha was harvested as first-cutting hay and incorporated into the rotational stocking system after 28 d. Over winter, cows were maintained in a drylot. In a first-last (FL) grazing system, six spring-calving cows with calves and 12 stocker cattle grazed paddocks in a rotational stocking system before six pregnant fall-calving Angus-cross cows for 55 d. In addition, forage from replicated 6.07 ha smooth bromegrass-red clover (SB-RC) and tall fescue-red clover pastures (TF-RC) was harvested as first-cutting hay and strip-grazed by spring-calving cows with calves and fall-calving cows for 50 d while stocker cattle grazed SB-OG-BFT pastures. Thereafter, stocker cattle were removed and spring- and fall-calving cows were again rotationally stocked in SB-OG-BFT pastures for 80 d. During winter, spring-calving cows grazed replicated 6.07 ha corn crop residues and stockpiled SB-OG pastures and fall-calving cows grazed stockpiled TF-RC pastures. Fall-calving and spring-calving cows were bred by natural service over 45 and 49 d in yr 1, respectively, and over 42 d in yr 2. No difference in average daily gains of spring calves and total growing animal production per hectare between systems was observed. Conception rates of spring-calving cows in the HH system were lower ($P < .01$) than spring-calving cows in the FL system in yr 1 and lower ($P < .01$) than fall-calving cows in the FL system in yr 2. Hay production per hectare did not differ between systems in yr 1, but was greater ($P < .05$) for the HH system than for the FL system in yr 2. Total perennial winter forage production per cow for the HH and FL systems were 1329, 4898 and 3272, 4681 kg DM in yr 1 and 2, respectively.

Key Words: beef cattle, rotational stocking, stockpiled forage

912 Liveweight and growth rate of cow-calf pairs grazing tall fescue pastures infected with either non-toxic (MaxQTM) or toxic endophyte strains. R.H. Watson*, M.A. McCann, J.A. Bondurant, J.H. Bouton, C.S. Hoveland, and F.N. Thompson, *The university of Georgia, Athens, GA.*

A trial was conducted to determine whether cow-calf pairs grazing tall fescue pastures infected with the non-toxic endophyte, MaxQTM, have better productivity than cow-calf pairs grazing tall fescue infected with the toxic, wild-type endophyte. Two 7.1 ha paddocks and two 7.3 ha paddocks were sown in tall fescue (*cv*: Georgia-5) infected with either the MaxQ or toxic endophyte. The 7.1 ha and 7.3 ha paddocks were stocked in early March with 15 and 16 cow-calf pairs respectively. The cow-calf groups were balanced for cow age, calving date, BW, and body condition-score (BCS). The pairs were grazed on their respective treatment pastures until the calves were weaned in late August. All cows and calves were weighed and blood sampled pre-treatment, and subsequently every 8 weeks, with a final weight recorded at calf weaning. Cows were visually assessed for BCS at these times. Blood samples were analyzed for prolactin as an indication of toxicosis. Serum prolactin levels were lower ($P < .01$) in cows and calves on toxic fescue (32 ng/ml, and 36 ng/ml respectively) than cows and calves on MaxQ fescue (94 ng/ml, and 101 ng/ml respectively). Cow BW and BCS were better ($P < .05$) at weaning in the MaxQ group compared with the toxic group (BW, 512 kg vs 486 kg respectively; BCS, 5.9 vs 5.3 respectively). Steer calves raised on MaxQ fescue had better ADG and weaning weights than all other groups of calves. Heifer calves raised on MaxQ fescue had better ADG and weaning weights than heifer calves raised on toxic fescue but were not different from steer calves raised on toxic fescue. The results indicate that grazing tall fescue infected with the MaxQ endophyte, as

opposed to toxic tall fescue, has the potential to eliminate toxicosis and greatly improve cow-calf productivity.

	Steer calves		Heifer calves	
	Toxic	MaxQ	Toxic	MaxQ
ADG (kg/d)	0.91 ^{a,b}	1.15 ^c	0.87 ^a	1.03 ^b
Weaning weight (kg)	226 ^{a,b}	260 ^c	207 ^a	230 ^b

^{a,b,c} Means on same row with different superscripts are different ($P < .05$)

Key Words: Cow-calf production, Toxic tall fescue, MaxQ

913 Non-toxic endophyte (MaxQTM) use for alleviating tall fescue toxicosis in stocker cattle. J.A. Bondurant*, M.A. McCann, J.H. Bouton, C.S. Hoveland, R.H. Watson, and J.G. Andrae, *The University of Georgia, Athens, GA.*

To address the problem of fescue toxicosis in grazing cattle, plant persistence-enhancing non-toxic endophytes from New Zealand have been incorporated into tall fescue cultivars grown in Georgia. The objectives of the present study were to determine animal performance and evaluate toxicosis in stocker steers and heifers grazing non-toxic endophyte-infected (MaxQTM), endophyte-free (EF), or toxic endophyte-infected (EI) tall fescue. Replicated (n=2) .809-ha tall fescue paddocks were established at the Central Georgia Branch Station near Eatonton, GA and at the Northwest Georgia Branch Station near Calhoun, GA with Jesup and Kentucky-31 tall fescue cultivars, respectively. Animals were stocked on the paddocks using put-and-take grazing management during four periods from Spring 1999-Fall 2000 that averaged 65 d each at Eatonton and 89 d each at Calhoun. Mean stocking rate at Eatonton was 7.1 hd/ha with no treatment differences ($P > .05$). At Calhoun stocking rate averaged 8.9 hd/ha and was higher ($P < .05$) on the toxic EI paddocks compared to the MaxQTM and EF paddocks. Forage available during grazing was approximately 3100 kg DM/ha at the central GA location and 1900 kg DM/ha at the northwest GA location. There were no differences ($P > .05$) seen among treatments for available forage with the exception that MaxQTM available forage levels were lower ($P < .05$) than toxic EI available forage levels during Fall 2000 at Calhoun. D-14+ serum prolactin was depressed ($P < .05$) on the toxic EI paddocks compared to the MaxQTM and EF paddocks during fall grazing at Eatonton and during both seasons at Calhoun. No differences ($P > .05$) were found in d-14+ rectal temperatures among the three treatments. ADG/hd and gain/ha were higher ($P < .05$) on the MaxQTM and EF paddocks than on the toxic EI paddocks in both trials. These results suggest that infecting tall fescue cultivars with non-toxic endophytes is a promising alternative for combating fescue toxicosis in stocker cattle.

Key Words: Tall fescue, Nontoxic endophytes, MaxQTM

914 Performance of beef cattle grazing endophyte-infected tall fescue or sod-seeded ryegrass. D.W. Sanson*¹ and D.F. Coombs², ¹Rosepine Research Station, ²Dean Lee Research Station, *LSU Ag. Center.*

Grazing endophyte-infected tall fescue was compared to grazing sod-seeded ryegrass in West Central Louisiana for two-years with mature beef cows. Seventy-six cows (551 kg) were randomized into four groups of 19 cows. Each group was assigned to 8.1 ha pastures that were subdivided into four 2 ha paddocks. Two pastures were previously established in endophyte-infected fescue along with bermudagrass and bahiagrass, while two bermudagrass/bahiagrass pastures were sod-seeded with ryegrass each fall. Cows were maintained on their assigned pastures throughout the year. Hay was available in the fall prior to calving when forage availability was not adequate for grazing. Cows, predominantly Angus, Simmental, and Hereford crosses, were exposed to Brangus bulls from late April to mid-June of each year. Conception rate was determined by rectal palpation in September. Calves were weaned in mid-October. The model for data analysis included treatment, year,

and the treatment X year interaction. In general, cow weight, cow weight change, or cow condition score were not affected ($P > .1$) by treatment, however, cows grazing ryegrass were heavier ($P = .04$) in September (600 vs 578 kg for ryegrass and fescue, respectively). Cows grazing ryegrass had higher ($P < .03$) condition scores (5.8 vs 5.6) prior to calving, however the difference was probably not of biological significance. Fall pregnancy rates were lower ($P = .03$) for cows that had grazed fescue (70.4%) compared to cows that grazed ryegrass (91.6%). Calves born to cows grazing fescue (38 kg) weighed less ($P = .02$) at birth than calves born to cows that grazed ryegrass (43 kg). There was no difference ($P > .2$) in calf weights at the end of the breeding season or at weaning due to grazing treatment. These data suggest a negative effect of grazing endophyte-infected fescue on pregnancy rates with mature beef cows under West Central Louisiana conditions.

Key Words: Fescue, beef cows, ryegrass

915 Effect of grazing tall fescue endophyte types on subsequent feedlot performance and carcass quality. S. K. Duckett¹, J. A. Bondurant¹, J. G. Andrae¹, J. N. Carter², M. A. McCann¹, T. D. Pringle², and D. R. Gill², ¹University of Georgia, Athens, ²Oklahoma State University, Stillwater.

Research was conducted to determine the effect of grazing tall fescue pastures with different endophyte types on subsequent feedlot performance and carcass quality of beef cattle. Cattle grazed tall fescue endophyte infected (TOXIC), free (EF), or non-toxic (MAXQTM) pastures for 84 d at the Central Georgia Experiment Station (CGES), Eatonton and 112 d at the Northwest Georgia Experiment Station (NWGES). Real time ultrasound measures of fat thickness (UFT), ribeye area (UREA), and intramuscular fat (UIMF) were collected at the end of grazing phase. Twenty-four crossbred steers from CGES and twenty-four Angus heifers from NWGES were transported to the Willard Sparks Feedlot (Stillwater, OK). At the feedlot, cattle were allotted by location, grazing treatment and pasture replicate to pens (4 hd/pen) and fed a high concentrate diet for 112 d. Cattle were weighed at 28-d intervals and pen feed intake data was recorded on a daily basis. Carcass data were collected after harvest. Data were analyzed with treatment, location and two-way interaction in the model. Interactions between treatment and location were non-significant ($P > 0.05$). MAXQTM and EF cattle gained 0.52 kg/d more ($P < 0.05$) than TOXIC during the grazing phase. UFT and UIMF were similar ($P > 0.05$) between grazing treatments. MAXQTM and EF cattle had larger UREA than TOXIC; however, UREA/cwt values were similar ($P > 0.05$). At the beginning and end of feedlot phase, MAXQTM and EF cattle were over 50 kg heavier ($P < 0.05$) than TOXIC. Feedlot ADG was similar ($P > 0.05$) among grazing treatments. Hot carcass weights were higher ($P < 0.05$) for MAXQTM and EF than TOXIC. Other carcass quality measures did not differ ($P > 0.05$) due to grazing treatment. Carcass value was higher ($P < 0.05$) for MaxQTM than TOXIC with EF being intermediate. Thus, TOXIC cattle did not compensate in the feedlot for lower gains attained in the grazing phase and remained lighter in weight than EF or MaxQTM throughout the feedlot phase.

Key Words: Fescue, Feedlot, Carcass

916 The Effect of Yeast (*Saccharomyces cerevisiae*) Mineral on Organic Matter Digestibility in Beef Cattle on Native and Fescue-based Pasture Grazing Systems. Dean Kobs* and Stephen Boyles, *The Ohio State University*.

Twenty cows were given ad-lib access to mineral mix (control) or yeast (Diamond V XP[®]) mineral mix over the course of a year. Organic matter (OM) digestibility of the pasture was measured by randomly sampling the forage base and collecting 10 fecal grab samples per animal over five days (at least two samples per day). The fecal collections were conducted at different times of the day and/or night to account for diurnal variation. The trial was conducted in the winter (December), and twice in the summer (June and August). In-vitro OM digestibility was measured in both forage samples and cow fecal samples (compiled within animal). The indigestible forage and feces were measured for acid detergent fiber (IADF). The IADF served as an internal marker to calculate OM digestibility. There was no significant difference between groups in both seasons. However, in both summer trials, there was a trend of increased June OM digestibility 47% vs. 43% ($P = 0.12$) and August OM digestibility 55% vs. 52% ($P = 0.14$) in the yeast-mineral supplemented

groups. The trend may imply yeast-mineral supplemented cattle have an increased ability to digest organic matter in the summer months.

Key Words: Yeast (*Saccharomyces cerevisiae*)

917 Effect of method of storage on protein and fiber fractions, and *in situ* digestibility of kikuyu grass (*Pennisetum clandestinum*) and guinea grass (*Panicum maximum*). J.R. Carpenter^{*1}, S.E. Ellis², and R.Y. Niino-DuPonte¹, ¹University of Hawaii at Manoa, Honolulu, HI USA, ²University of South Carolina, Columbia, SC USA.

Cattle production in tropical/sub-tropical regions is limited by the available pastures' ability to support growth, reproduction, and lactation due to their high moisture and fiber, and low protein and energy content. The objectives of this experiment were to determine the effect of method of storage (direct cut, wilted silage, haylage and hay) on protein and fiber fractions and their relationship to extent and rate of dry matter, protein and fiber digestion. Six-week old kikuyu grass (KG) and guinea grass (GG) were harvested, chopped, then wilted to various moisture levels before being stored as silage or haylage in replicated experimental silos or as hay. After 30 d, subsamples from each storage method were analyzed for DM, fiber and protein fractions, and *in situ* digestibility. CP, NDF, ADF, and cellulose (averaged across storage methods) were 14.7, 65.7, 35.6, and 25.2% for KG and 8.6, 70.1, 44.7, and 31.8% for GG, respectively. *In situ* extent and rate of digestion differed ($P < .05$) both between grasses and storage method. Extent of digestion for DM, CP, NDF, and ADF (averaged across storage methods) were 54.2, 65.3, 45.4, and 47.4% for KG, and 43.9, 70.9, 46.6, and 45.1% for GG, respectively. Rates of DM, CP, NDF and ADF tended to increase as moisture content decreased for GG, but the opposite trend was observed for KG. For both grasses, the proportion of hemicellulose to NDF and to cellulose decreased and cellulose to ADF increased with decreasing moisture content. The proportions of soluble N decreased and insoluble available N increased as moisture content of storage method decreased. Data suggest that the method of storing tropical grasses alters both the nutrient composition, particularly the protein and fiber fractions, and the rate and extent of *in situ* digestion.

Key Words: Tropical grass and Silage/Haylage, Protein and fiber fractions, *In situ* digestibility

918 Characterization of season and sampling method effects on forage quality in fescue-based pastures. T.M. Dubbs*, E.S. Vanzant, S.E. Kitts, R.F. Bapst, B.G. Fieser, and C.M. Howlett, *University of Kentucky, Lexington*.

Information describing effects of seasonal changes and sampling methods on measurement of forage quality is limited for fescue-based pastures. Eight continuously-grazed, .76-ha, fescue-based pastures were used to compare forage type, method of collection, and seasonal effects on forage quality in a repeated measures, split-plot design. Four pastures were interseeded with red clover during March 2000. Masticate (M; from 4 ruminally-cannulated steers) and hand-clipped (C) samples were collected every 28 days from May until October 2000. In general, interseeding red clover in tall fescue-based pastures did not contribute ($P > .10$) to differences in OM, CP, NDF, ADF, or protein degradability characteristics. Sampling method effects were not evaluated for protein degradability characteristics. Sampling method and season interacted ($P < .03$) for OM, CP, NDF, and ADF. Concentrations of OM were greater ($P < .01$) for C than M in all months and responded quadratically ($P < .01$) to month for both C and M (C: 93, 93, 94, 94, 94, and 93%; M: 91, 89, 87, 88, 87, and 89% for May-October). NDF (C: 69, 73, 75, 74, 72, and 63%; M: 66, 68, 66, 66, 65, and 62% for May-October) and ADF (C: 35, 39, 42, 38, 37, and 31%; M: 33, 35, 33, 34, 34, and 31% for May-October) were greater ($P < .01$) for C than M in all months except October ($P > .10$) and were described by quadratic ($P < .01$) responses across month, except for NDF with C, which was cubic ($P = .04$). Crude protein (C: 13, 11, 12, 13, 14, 17%; M: 16, 15, 18, 18, 18, and 18% for May-October) was lower ($P < .01$) in C than M in all months except October ($P > .10$) and was quadratic ($P < .01$) across months for C, and cubic ($P < .01$) for M. Within M, concentrations of A, B, and C protein fractions, determined from *in situ* analysis (uncorrected for microbial attachment), responded cubically ($P < .01$) to month, whereas protein degradation rate decreased linearly ($P < .01$) from May-October. Estimates of protein degradability responded cubically (72, 61, 64, 67, 65,

and 67% for May-October). In its first growing season, red clover interseeded into fescue pastures did not influence quality of diet selected by grazing steers. Differences between clipped and masticate samples were substantial until late season, when opportunities for selective grazing were minimal.

Key Words: Fescue, Season, Quality

919 Performance of high producing dairy cows with three feeding systems combining pasture and total mixed rations. F. Bargo*, L. D. Muller, J. E. Delahoy, T. W. Cassidy, and J. L. Amick, *The Pennsylvania State University, University Park.*

Forty-five Holstein cows [15 primiparous and 30 multiparous (6 rumen cannulated); 624 kg BW; 44.9 kg/d milk; 109 DIM] were used in a repeated measures design of 21 weeks to study the effect of three feeding systems on animal performance and rumen digestion. Cows were blocked by lactation number and DIM, and randomly assigned to three treatments: pasture + concentrate (PC); pasture + total mixed ration (TMR) (partial TMR; pTMR); and total mixed ration (TMR). Cows on PC and pTMR grazed a grass pasture offered at 30 kg DM/cow/d plus a corn-based concentrate (1 kg/4 kg of milk for PC and an amount to maintain a similar forage:concentrate ratio between PC and pTMR for pTMR). Cows on TMR were fed ad libitum with a nutritionally balanced TMR. Pasture, concentrate and TMR had 26.3, 15.2, and 16.6% CP; 49.9, 15.7 and 30.1% NDF, respectively. Total DMI was measured 4 times in all three treatments using Cr₂O₃ as fecal marker. The highest total DMI and milk production were obtained with the TMR diet, the lowest with the PC, and intermediate with the pTMR. Both the TMR and the pTMR treatments had a higher milk fat and protein percentage than the PC treatment. Cows on PC and pTMR gained less BW (27 and 40 kg, respectively) than cows on TMR (76 kg). Concentration of rumen ammonia N and MUN were significantly lower in TMR and pTMR treatments than in PC treatment. Rumen pH and total VFA concentration were not affected by treatments. The combination of pasture and TMR resulted in a higher milk production with a higher fat and protein content and a better dietary N utilization than the pasture plus concentrate combination.

	PC	pTMR	TMR	SEM
Milk, kg/d	28.5 ^a	32.0 ^b	38.1 ^c	1.15
Fat, %	3.13 ^a	3.35 ^b	3.30 ^b	0.05
True protein, %	2.82 ^a	2.95 ^{ab}	2.99 ^b	0.05
MUN, mg/dl	14.93 ^a	12.01 ^b	10.55 ^c	0.41
Rumen NH ₃ -N, mg/dl	19.96 ^a	10.75 ^b	9.74 ^b	0.48
Concentrate DMI, kg/d	8.7 ^a	2.2 ^b	-	0.11
Pasture DMI, kg/d	13.0 ^a	7.5 ^b	-	0.34
TMR DMI, kg/d	-	15.5 ^a	26.8 ^b	0.40
Total DMI, kg/d	21.7 ^a	25.2 ^b	26.8 ^c	0.47

^{a, b, c}Least square means with different superscripts differ $P < 0.05$

920 Application of a pasture intake model in an educational package to enhance farmer uptake of pasture quality management technologies. S.J.R. Woodward* and M.G. Lambert, *AgResearch Limited, Hamilton, New Zealand.*

Accurate feeding of livestock on pasture depends on a farmer's ability to estimate the quantity and quality of the feed components on offer, and then to predict what animals will eat while grazing. An educational package was developed to better enable New Zealand sheep and beef farmers to manage pasture quality on-farm. The package was designed to promote farmers' (1) understanding of pasture quality, (2) measurement of pasture quality on-farm, (3) prediction of animal responses to pastures with an estimated quality, and (4) management of pasture quality for feeding livestock to achieve pre-determined performance targets. Part of the objective was achieved by constructing a computer-based decision support tool, Q-Graze. A farmer enters field estimates of pasture quality, along with stock and grazing management information, and Q-Graze then predicts changes in herbage mass and quality, intake, and liveweight gain responses of animals. This allows the farmer to check that liveweight gain targets will be met, and if not, to alter his or her grazing plan accordingly. Predicting grazing behavior, intake, and liveweight gain is complicated because of the dynamic interplay between pasture mass and quality, intake rate and composition, rate of digestion, and animal energy metabolism. Mathematical models are the most appropriate tool for simulating these interactions. Underlying Q-Graze is

a pasture intake model that calculates bite size, bite composition, bite handling time (including ruminating), and energy intake rate. The ratio of energy intake rate to animal energy demand is used to determine the animals' instantaneous feeding effort (the time derivative of grazing time plus ruminating time). This allows the seamless integration of four constraints to intake: satiation, digestive capacity, resting requirements, and cessation of feeding when net energy assimilation rate falls below zero. Daily dry matter and energy intakes can then be calculated, and used to predict animal growth. The successful application of this pasture intake model is possible because it is embedded in a user-friendly software tool (Q-Graze). Use of Q-Graze by farmers during its development allowed them to shape the software, and contributed to their learning about pasture quality.

Key Words: Decision support software, Sheep, Beef cattle

921 Using *in sacco* and *in vitro* incubations to determine the digestion and fermentation kinetics of fresh forages. J.L. Burke*^{1,2}, G.C. Waghorn¹, L. G. Barrell^{1,2}, I. M. Brookes², G.T. Attwood¹, and E. S. Kolver³, ¹AgResearch, ²Massey University, ³Dexel Ltd, New Zealand.

The objective of this study was to estimate the nutritive value and digestion kinetics of New Zealand forages using *in sacco* and *in vitro* incubations. Initial studies using three fresh forages (*Trifolium repens*, *Lolium perenne* and *Lotus corniculatus*) indicated that mincing was a more suitable preparation for incubation than either freeze drying and grinding or chopping to 6-mm lengths. Digestion kinetics were determined on 23 contrasting fresh forages following mincing to a particle size similar to chewed material. Forages (2.5 g wet) were incubated *in vitro* at 39°C for 24 h with McDougals buffer, rumen liquor (obtained from a Friesian cow fed good quality lucerne hay) and cysteine sulphate reducing agent. Triplicate bottles of each forage were removed after 0, 2, 4, 6, 8, 10, 12 and 24 h of incubation and sub-sampled for ammonia, VFA and pH determination. 100 mm x 100 mm dacron bags containing 30 g of each forage were placed in the rumen of the cow. Duplicate bags were removed at 0, 2, 6, 12, 24 and 72 h, hand-rinsed in cold water, dried at 60°C for 48 h and residues were analysed by NIRS to estimate nutrient content. Kinetic parameters of DM and nutrient disappearance over time were predicted by fitting data from bag residues to a non-linear model (Orskov and McDonald, 1979). Estimates of DM solubility (%DM) and fractional DM degradation rates (h⁻¹) were: temperate grasses (48, 0.09); legumes (42, 0.14); tropical grasses (29, 0.06); silages (45, 0.10); herbs (40, 0.25). High nitrogen legumes released up to 43% of plant-N over 24 h. Low nitrogen tropical grasses released a maximum of 8% of the plant-N after 6 h, and losses of plant-N decreased thereafter. These data will be used as a scientific basis for formulating forage-based rations in which the components complement each other in terms of their digestion and fermentation characteristics. Such rations may then be incorporated into New Zealand grazing systems to optimise the nutrient supply for high-producing dairy cows.

Key Words: Forages, *in vitro*, *in sacco*

922 Condensed tannins in legumes increase milk production of dairy cows. S.L. Woodward*, E.B.L. Jansen, and P.J. Laboyrie, *Dexel Ltd, Hamilton, New Zealand.*

New Zealand dairying relies on ryegrass (RG)-white clover pastures. *Lotus corniculatus* is an alternative legume species which, when grazed by lactating dairy cows, results in higher milk yield than either RG or white clover. It was thought that condensed tannins (CT) contributed to this increase. CT (phenolic compounds in some legumes including *Lotus*) bind to plant proteins and reduce microbial degradation of soluble protein to ammonia. This increases non-ammonia nitrogen flux to the abomasum and small intestine, and absorption of amino acids from the small intestine. Three indoor feeding trials were conducted to determine what proportion of milk yield and milk composition changes were due to CT in *Lotus*, and what proportion was due to factors common to all legumes. Friesian dairy cows in mid- to late-lactation (125-226 days in milk) were fed either RG or *Lotus*, and were drenched with either polyethylene glycol (PEG) solution or water. CT bind to PEG in preference to plant proteins thereby rendering the CT inactive. Comparing cows on RG (21.4%DM; 17.4% crude protein; 10.7 MJ ME/kg DM; 0% CT) or *Lotus* (16.0%DM; 23.7% crude protein; 11.6MJ ME/kg DM; 2.63% CT) diets with CT-inactivated cows (+PEG) allowed effects of CT in *Lotus* to be quantified. Higher milk yield of cows fed *Lotus*

was due to a combination of legume factors (higher intake and forage quality), and CT effects, which contributed 42% of the increase in yield. CT also contributed 65% of the increase in milk protein concentration and 100% of the increase in conversion efficiency, but did not contribute to the increase in intake or decrease in milk fat concentration. *Lotus* has potential as a forage for dairy cows, although its low herbage yield compared with traditional forages necessitates further investigation of management options for inclusion of *Lotus* into the farm system. Table: Means (30 cows) and SEDs of combined data from all three trials.

	RG	RG+PEG	Lotus	Lotus+PEG	SED
Milk yield (kg/cow/d)	12.87	12.70	18.88	16.22	0.58
Intake (kgDM/cow/d)	15.05	14.69	17.03	16.98	0.65
Fat (%)	4.74	4.70	4.48	4.46	0.12
Protein (%)	3.22	3.19	3.48	3.30	0.05
Efficiency (ml FCM/MJ ME)	139	136	166	137	8

FCM: fat corrected milk

Key Words: Dairying, Tannins, Milk

923 Nutrient composition of forages in Arkansas, 1985-1999. G. V. Davis*, M. S. Gadberry, and T. R. Troxel, *University of Arkansas Cooperative Extension Service, Little Rock, AR.*

The objective of compiling a statewide forage database was to determine the average nutrient composition and variability of forages produced in Arkansas. The database consists of 11,592 forage samples (10,246 hay, 1,001 pasture and 345 silage) collected from 1985 to 1999. Forage samples were analyzed for 1 to 15 nutrients. These included DM, N, ADF, NDF, P, K, Ca, Mg, Na, S, Fe, Mn, Zn, Cu and Se. The mean \pm SD CP and TDN levels (% DM) of bermudagrass (n = 3,007), fescue (n = 904), mixed grass (n = 2,394) and all hays (n = 8,316) were, respectively; 12.4 \pm 3.5, 60.0 \pm 6.2; 11.2 \pm 3.0, 53.8 \pm 4.7; 11.1 \pm 3.1, 52.9 \pm 4.7; and 12.0 \pm 3.8, 56.8 \pm 6.6. For beef cows and calves, TDN was deficient in a higher percentage of hays (P < 0.05) than CP. Bermudagrass hay contained greater (P < 0.05) levels of CP and TDN, but lower (P < 0.05) levels of P and Mg than fescue or mixed grass hays. Fescue and mixed grass hays did not differ (P > 0.05) in CP, ADF, NDF or TDN concentrations. Mixed grass hay contained greater (P < 0.05) levels of Ca but less (P < 0.05) S than bermudagrass. Fescue hay had less (P < 0.05) Cu and Zn than bermudagrass or mixed grass hays. Sodium was the most deficient mineral in all hays. Only 6 to 10% of the hays analyzed for Na contained adequate levels for beef cows and calves. Trace minerals Se, Cu, and Zn were deficient in 60, 52 and 41% of the samples, respectively.

ASAS/ADSA Growth and Development: Ruminant Growth and Mammary Development

925 Effects of a dairy calf starter containing yeast culture on daily grain intake, weight gain, structural growth, and rumen development in dairy calves. K. E. Lesmeister* and A. J. Heinrichs, *The Pennsylvania State University, University Park, Pennsylvania.*

The effects of supplemental yeast culture on daily grain intake, weight gain, structural growth, and rumen development were analyzed using 75 Holstein calves (38 male and 37 female) fed one of three grain starters containing a yeast culture (*Saccharomyces cerevisiae*, Diamond V Mills, Inc.) at 0 (C), 1% (1Y), or 2% (2Y) of the ration in a randomized block design. Calves were placed on trial at 2 1 d of age and maintained on trial for 42 d. A non-medicated milk replacer (20% CP, 20% fat) was fed in two equal feedings totaling 10% of birthweight until abrupt weaning at 35 d on trial. Grain and water were provided daily on an ad-lib basis, with grain intake (GI) being measured daily. Measurements of bodyweight (BW), wither height (WH), hip height (HH), hip width (HW), and heart girth (HG) were recorded at 0, 7, 14, 21, 28, 35, and 42 d on trial. Incidences of scours were recorded daily (DS). Two calves per treatment were slaughtered at 42 d, weights of empty stomach compartments (CE) were recorded, and rumens sampled for analysis of papillae length (PL), papillae width (PW), wall thickness (WT), and papillae/cm² (PC). No differences were observed between sexes for all variables. Average daily GI was greater (P = 0.029) for 2Y (0.687 kg/d) than for C (0.602 kg/d). Average daily gain was numerically greater for 2Y (0.340 kg/d) compared to C (0.304 kg/d) and 1Y (0.287 kg/d). Average daily change in HW was greater (P = 0.013) for 2Y (0.064 cm/d)

A lower percentage of the hays were deficient in P, Ca, Mg and S. Fe, Mn and K were deficient in 2% or less of the hays. Wheat, ryegrass, legume-grass and fescue pastures tended to contain greater levels of CP and TDN than the other pasture forages analyzed. Bermudagrass, corn, and sorghum-sudan silages contained greater (P < 0.05) levels of TDN than the other silages. This information was provided to county Extension agents, cattle producers, and cattle-related industries to promote forage testing by cattle producers and provide general feeding recommendations whenever a forage test was unavailable.

Key Words: Hay, Pasture, Forage composition

924 Frontal grazing for cattle management on annual ryegrass pasture. H. Lippke*¹, T. D. A. Forbes¹, R. V. Machen², and B. G. Warrington¹, ¹*Texas Agricultural Experiment Station, Uvalde, TX,* ²*Texas Agricultural Extension Service, Uvalde, TX.*

An experiment was conducted to develop a modified frontal grazing system (FGS) based on center pivot irrigation machinery and to compare that system to a traditional continuously stocked management system (CGS) with respect to (a) ADG by yearling steers grazing ryegrass (*Lolium multiflorum*) and (b) livestock production/unit land. In the FGS, a break wire was attached to the towers of the outer 98 m of a 244-m center pivot. Concentric rings of temporary fence restrained lateral movement of the steers, while a manually advanced back fence restricted the cattle to a 15 to 20-degree arc of the circle. Pivot towers were advanced at a rate such that 30% of the ryegrass leaf lamina remained with the ungrazed plant residue. The CGS was lightly stocked initially at 593 kg animal weight/ha. The FGS was initially stocked with 1038 kg animal weight/ha. With the onset of spring growth, cattle were added to both systems so that at the mid-point of the 156-d grazing season, the CGS and the FGS supported 1094 and 1989 kg animal weight/ha, respectively. As an additional measure to control forage growth, 25% of the CGS and 20% of the FGS was de-stocked during the month of March, harvested as high-moisture hay, and restocked in mid-April. Average daily gain for steers on the CGS (1.22 kg) was greater (P < .01) than ADG for steers on the FGS (1.08 kg). Animal production/unit land was greater (P < .01) for the FGS (834 kg/ha) than for the CGS (668 kg/ha). If the animal production potential of the hay harvested from these systems is included, the FGS again produced more (P < .01) gain than the CGS (873 vs 746 kg/ha). Frontal grazing offers instant flexibility in cattle management and sufficient promise of higher productivity to be further evaluated in comparison with an array of stocking densities under continuous grazing.

Key Words: Grazing system

than for C (0.052 cm/d). A trend (P = 0.128) for PC from the caudal ventral rumen wall was also observed between C and 2Y (938.75 vs. 711.06 papillae/cm²). No treatment differences were observed for BW, WH, HH, HG, DS, CE, PL, PW, and WT. These data suggest that the addition of yeast culture in a dairy calf grain starter at 2% of the ration positively influenced average daily grain intake, ADG, hip width, and rumen papillae/cm².

Key Words: Dairy Calves, Intake, Rumen Development

926 Calf serum IgG concentrations affects weaning performance. R. C. Vann* and J. F. Baker, *University of Georgia, Tifton, GA/USA.*

The objective of this study was to determine if calf serum IgG concentrations at 24 h of age affects growth performance to weaning. Calves were born in January or February in two consecutive years and weighed monthly beginning in March until weaning in early September. Colostrum samples were collected from Angus (n=94) and Polled Hereford (n=38) cows at the Tifton location and crossbred (n=112) cows at the Alapaha location within 8 h after parturition and serum samples collected from their calves at 24 h of age. The serum and colostrum immunoglobulin (Ig) concentrations were determined using radial immunodiffusion (RID) kits. Calf serum IgG concentrations were classified as Superior (S) Ig concentration (above 1600 mg IgG/100 ml), Average

(A) Ig concentration (between 400 and 1600 mg IgG/100 ml) and inferior (I) Ig concentration (below 400 mg IgG/100 ml). Failure of passive transfer (FPT) rate (IgG concentration below 800 mg IgG/100 ml) in the first year at the Tifton location was 19.4% and at the Alapaha location 12.5%, however, the FPT rate in the second year was 38.6% at the Tifton location and 32.9% at the Alapaha location. The FPT rate for the two years combined was 34.1% at the Tifton location and 28.6% at the Alapaha location. Data were analyzed by Proc MIXED using a model that included fixed effects of dam breed, year, and FPT class. Covariates included were cow IgG, cow IgM, cow IgA, birth weight and birth day of year. The effects of birth weight, birth day of year and FPT classification were significant for periodic weights and weaning weight. Breed of dam did not have a significant effect on colostrum or calf IgG concentration. Weight gains from March to weaning followed a linear trend, however, at the March weight the S calf group were 3 kg heavier than the A group and 7 kg heavier than the I calf group, and at weaning the S calf group were 14 kg heavier than A group calves and 29 kg heavier than the I calf group. Calves in the A and S FPT groups were significantly heavier at all weigh periods and at weaning compared to calves in the I FPT group.

Key Words: Beef calves, Immunoglobulins, Growth

927 Plasma IgG concentration in neonatal calves in response to a colostrum supplement or colostrum replacer and addition of deoxycholic acid. J. D. Quigley*, C. A. Kost, and T. M. Anspach, *APC Company, Inc., Ames, IA.*

Absorption of IgG from the intestine of neonatal calves is influenced by the milieu in which the IgG are presented. The presence of excess protein or selected ions may affect absorption of IgG during the neonatal period. Bile salts are powerful emulsifiers that affect absorption of fats, vitamins and other compounds and may influence IgG absorption. Our objective was to determine if deoxycholic acid (DOCA) affected IgG absorption in calves fed a colostrum supplement (CS) or colostrum replacer (CR). Holstein bull calves ($n = 33$) were removed from the dam within 10 min of birth, weighed, and fed 454 g of a commercially available CS (Lifeline Nutritional Colostrum Supplement, APC Company; 10% IgG) or an experimental CR (20% IgG) containing IgG extracted from bovine plasma. The CR and CS were mixed in a blender with 1.9 L of water per feeding. In addition, 0 or 2 g of DOCA were added at each feeding. Calves were fed by esophageal feeder at 1 and 8 h of age. Intake of IgG was 90 and 187 g for CS and CR, respectively. Jugular blood was collected at 0.2 and 24 h of age and analyzed for IgG by turbidimetric immunoassay and total protein by biuret. Plasma IgG and total protein at 0 h were unaffected by dietary treatment and were 0.4 g/L and 4.57 g/dL, respectively. Addition of DOCA had no effect on any parameter measured. Plasma IgG at 24 h in calves fed CR was higher ($P < 0.001$) than in calves fed CS (13.6 vs. 8.0 g/L); however, plasma protein was not different (4.99 vs. 4.98 g/dL). Plasma IgG at 24 h in calves fed CS and CR ranged from 4.8 to 12.9 and 9.9 to 17.5 g/L, respectively. Apparent efficiency of IgG absorption was similar between CS and CR and was 33 and 30%, respectively. Relationship between plasma IgG and total protein at 24 h varied by treatment. For CS, regression equation was plasma IgG (g/L) = $4.92 \times$ plasma protein (g/dL) = 16.5; $r^2 = 0.77$. For CR, regression equation was plasma IgG (g/L) = $5.38 \times$ protein (g/dL) = 12.5; $r^2 = 0.59$. The CR used in this study effectively prevented failure of passive transfer in neonatal calves; however addition of DOCA did not influence IgG absorption.

Key Words: calves, colostrum, immunoglobulin

928 Intake, growth and efficiency of calves fed milk replacers containing whey protein concentrate or alternative animal proteins. J. D. Quigley*, C. J. Kost, and M. L. Miller, *APC Company, Inc., Ames, IA.*

Protein ingredients in calf milk replacers (CMR) contribute significantly to the overall cost of the product and alternatives to dried skim milk and whey protein concentrate (WPC) have been evaluated extensively. Spray-dried hydrolyzed red blood cells (SDHRBC) and bovine plasma (SDBP) have been compared to CMR containing WPC. However, the effects of SDHRBC and SDBP in the same formulation have not been determined. Our objective was to compare the performance of calves fed CMR based on WPC or SDHRBC alone or in combination with SDBP. Holstein bull calves ($n = 120$) were purchased from area dairies or sale barns and were assigned to receive CMR containing WPC, or 10% of the

formula as SDHRBC or 10% SDHRBC plus 4% SDBP. All CMR were formulated to contain 23% and 21% of DM as crude protein and ether extract, respectively. Calves were housed in individual hutches and fed 454 g/d of CMR reconstituted to 12% DM for 24 d. Commercial calf starter and water were available throughout the study. Mean BW on d 0, 28 and 56 were unaffected by treatment and were 48.1, 58.5 and 89.5 kg, respectively. Mean intake of DM from CMR from d 0 to d 24 was 413 g/d; intake of calf starter and water were 1308 g/d and 3.6 L/d, respectively from d 0 to 56. Mean fecal scores, days scouring and days treated tended to be higher in calves fed SDBP, although much of the increase in veterinary treatments occurred during the last 2 wk of the study. Mean fecal scores were 1.65, 1.64 and 1.72 in calves fed WPC, SDHRBC and SDBP, respectively. Mean days with scours were 5.5, 5.3, and 8.3, respectively. There were few differences in physical characteristics of the CMR and acceptance by the animals was excellent. Spray dried bovine plasma may be included in CMR formulations containing SDHRBC.

Key Words: calves, milk replacer, intake

929 Economics of dairy heifer growth programs. C.A. Wolf* and M.J. VandeHaar, *Michigan State University, East Lansing, MI/USA.*

Interest in rapid growth rates for replacement heifers occurs because breeding date, and subsequent calving/lactation, is determined by size. General agreement exists that heifers should be bred when they are 340 to 380 kilograms regardless of age. Given the weight standard, a heifer that grows at a faster rate will achieve the breeding size at a younger age. Accelerated growth rates, gains over 900 grams/day, put heifers at risk for impaired mammary development and have been found to be detrimental to milk production with declines of 5 to 48 percent in the first lactation. The potential advantages of reduced age at first calving include decreased feed costs and lower overhead while the potential disadvantages include lower milk production and the cost of increased planes of nutrition. The tradeoff between potential savings in heifer raising costs and milk production loss is examined in a basic economic model using parameter values from the dairy science literature. The analysis uses 20, 22 and 24 months age to first calving. In a short-run framework, facility and enterprise size variables are held constant and the cost change is driven by the feed costs determined using least-cost rations. Least cost rations indicate that total feed costs decline from 22 to 24 months age at first calving but are essentially constant and may even increase marginally when heifers are grown at rates required to calve at 20 months relative to the 22 month scenario. The savings in feed cost are small enough that even a five percent decline in milk yield in the first lactation will off-set the savings. In a long-run analysis accelerated heifer growth implies less need for facilities and other infrastructure associated with the heifer enterprise and overhead costs decline with age to first calving. Sensitivity analysis is used to compare the changing heifer enterprise costs with milk income loss values using data from the economics literature. The results indicate that milk yield loss is the important factor in the short-run while fixed cost changes substantially affect the long-run heifer growth rate decision.

Key Words: Heifer growth, Economic analysis

930 Effects of added rumen undegraded protein (RUP) and bovine somatotropin (bST) administration on mammary gland growth in prepubertal dairy heifers. A. V. Capuco*¹, G. E. Dahl², D. L. Wood¹, and R. A. Erdman², ¹USDA-ARS, Beltsville, MD, ²University of Maryland, College Park, MD.

The objective of this study was to test effects of added rumen undegraded protein (RUP) and recombinant bST administration on growth of mammary glands of dairy heifers from 90 d of age until 10 mo of age (peripubertal). Thirty-two Holstein heifers (90 d of age) were used in the experiment, eight of which were slaughtered at 90 d, prior to being assigned to treatment. The remaining twenty-four heifers were randomly assigned to one of four treatment groups. Treatments consisted of added dietary RUP (2% RUP, 14.9% CP, DM basis) and 0.1 mg of bST/kg BW/d applied in a 2 x 2 factorial design. Twelve heifers (3 per treatment) were slaughtered at 5 and 10 mo of age. Mammary parenchymal growth was not affected by RUP or bST treatment ($P > 0.1$). Total parenchymal mass increased from an average of 16 g to 364 g, and parenchymal DNA from 58 mg to 1022 mg from 3 mo to 10 mo of age, respectively. Total parenchymal fat increased from 82 g at 3

mo to 618 g at 10 mo of age. Furthermore, the number of mammary epithelial cells likely was not affected by diet or bST because neither total parenchymal DNA nor the lipid content of parenchyma was affected by treatment ($P > 0.1$). Results suggest that mammary parenchymal growth was neither enhanced nor inhibited by RUP or bST at the feeding rates employed in this study.

udder half (10 mo)	Treatment ¹				
	Control	bST	RUP	RUPbST	SE
Parenchyma, g	401	347	345	361	44
Extraparenchymal fat, g	555	539	880	499	68
Fat/parenchyma	1.42	2.22	2.53	1.39	0.25
mg Lipid/g parenchyma	333	380	336	408	37
mg RNA/g parenchyma	0.94	1.00	0.99	0.87	0.07
mg Protein/g parenchyma	16.5	13.9	18.6	14.6	1.2
Total Fat, g	133	120	120	157	21
Total DNA, g	1.05	0.93	1.01	1.10	0.13

¹No significant main or interaction effects ($P > 0.05$)

Key Words: bST, RUP, Mammary growth

931 Physiological responses and growth rates of dairy heifers when raised from birth to weaning during hot weather. Tomas Belloso^{*1}, R.A. Bucklin¹, H.H. Head¹, M.J. Hayden¹, A.N. Garcia¹, M.S. Gulay¹, and F. Baccari², ¹University of Florida, Gainesville, Florida, ²Universidade Estadual de Londrina, Londrina-PR, Brasil.

Objectives were to evaluate effects of hot weather on physiological responses, hormone concentrations, and growth rates of newborn heifers from birth to weaning. Twelve heifers were assigned to each of three housing systems by d-3 of age. These were in calf barn without (H1) or with fans (H2), and outside calf-pens (H3). Approximately equal numbers of heifers with low (C1, <5.0 g/dl) or high (C2, <5.0 g/dl) levels of total plasma protein on d-3 of age were in each H. Fans provided air movement across heifers in H2. Heifers were fed milk replacer twice daily through d-42 then once daily until weaned (d-49). Water and dry feed (>15%CP) were available free choice and intakes measured once or twice daily, respectively. Body weight and height at withers were measured when assigned and then once weekly. Blood samples were collected twice weekly, plasma harvested and frozen until analyzed for concentrations of somatotropin (ST), insulin (INS), insulin-like growth factor-1 (IGF-1), triiodothyronine (T₃), and thyroxine (T₄). Rectal temperature (RT) and respiration rate (RR) were recorded one day a week over a 24-h cycle at 0700, 1100, 1500 and 1900, and at 0700 h. Mathematical models included H, C and H*C. Highest and lowest mean RT (39.81±0.04 and 38.71±0.03) and RR (66.7±1.71 and 35.33±1.68) were at 1900 h and 0700 h, respectively; daily trends followed daily ambient temperature. Significant effects of H were detected only for T₃ (H1>H2,H3) and mean daily water intake (2.8, 2.5 vs. 3.5 L/d). Differences were detected among C groups. Calves in C2 had greater mean daily water intake ($P < 0.0119$) and DMI ($P < 0.0404$). They grew faster than heifers in C1 (0.265 vs. 0.239 kg/d, $P < 0.0415$; and 6.1 vs. 4.3 cm increase, $P < 0.0517$). They also had significantly higher mean concentrations of T₃, T₄ and INS in plasma. No significant interactions (H*C) were detected except for RR; it was greater in C2 except for H1. Importance of providing newborn calves with colostrum and growing heifers with water and feed free choice during summer months was confirmed. Increased water consumption by heifers, especially in H3, likely allowed them to dissipate greater heat load and to maintain body temperature, physiological responses and growth rates the same as heifers in H1 and H2.

Key Words: Heifers, Heat stress, Growth

932 Analysis of cell proliferation in the prepubertal bovine mammary gland. S. Ellis^{*1} and A.V. Capuco¹, ¹USDA-ARS-GEML Beltsville, MD 20907.

The focus of this research was to investigate the growth and development of the prepubertal ruminant mammary gland. Detailed histologic analyses were conducted to characterize the proliferation of mammary epithelial cells and to determine how each of the mammary cell types contribute to mammary development. Holstein heifers were slaughtered at 2, 5, and 8 mo of age to provide tissues for this study (n = 3 per age group). Each heifer was injected intravenously with bromodeoxyuridine

(BrdU, 0.5 mg/kg body weight in pH 8.5 saline) 2 h prior to slaughter to label S-phase cells. After slaughter, mammary parenchymal tissue samples were collected from peripheral, medial, and cisternal parenchymal regions. Tissues were then fixed, embedded, and sectioned at 0.9 μm. Sections were immunohistochemically labeled to detect BrdU and stained with a mixture of Azure II and basic fuchsin. Current models of mammary development in rodents suggest that a population of small, basally located, lightly-staining cells (SLC) function as mammary stem cells. In the present study, three distinct levels of cytoplasmic staining were observed in mammary epithelial cells: light, intermediate, and dark. As in the rodent mammary gland, BrdU-positive SLC were observed in all parenchymal zones. BrdU-positive SLC were also observed in contact with the ductal lumen, in contrast with the current rodent model. BrdU labeling was also observed in cells with intermediate and dark cytoplasmic staining. Preliminary results from these analyses reveal both similarities and distinctions from the current model of mammary epithelial cell proliferation in murine mammary glands. The results of these analyses provide critical insight into the cell types involved in ruminant mammogenesis. This information will aid in the development of therapies that improve prepubertal mammary development and increase the return on investment in replacement heifers.

Key Words: Mammary Development, BrdU, stem cell

933 Leptin receptor expression in the bovine mammary gland and other tissues. L.F.P. Silva^{*}, M.J. VandeHaar, M.S. Weber, and G.W. Smith, Michigan State University, East Lansing, MI.

The effect of leptin on food intake and energy metabolism relies on leptin receptors (Ob-R) located in the central nervous system. Several peripheral actions of leptin have also been reported, and Ob-R mRNA has been detected in peripheral tissues of human, rodent, pig and sheep. We believe leptin may modulate mammogenesis in heifers. Thus, our objective was to characterize Ob-R expression in mammary and other tissues of prepubertal dairy heifers. We used reverse-transcription PCR to detect Ob-Rb, the long splice variant which has an intracellular signaling domain essential for leptin's weight-reducing effects, and Ob-Ra, a short isoform with unidentified signaling capabilities. Ob-Rb mRNA was detected in all tissues examined: hypothalamus, pituitary, heart, spleen, liver, lung, ovary, testis, skeletal muscle, subcutaneous adipose tissue, primary mammary epithelial cells, mammary extra-parenchymal adipose tissue, a bovine mammary epithelial cell line (MAC-T) and mammary tissue (parenchyma + stroma) from a heifer two months after puberty. However, in contrast with reports in other species, expression of Ob-Ra was detected only in bovine liver, pituitary, subcutaneous adipose tissue and spleen. The partial deduced amino acid sequence (134 a.a.) for bovine Ob-Rb shared 92, 78, 73 and 68% similarity with the reported Ob-Rb sequences for ovine, swine, human and rat, respectively. The partial amino acid sequence (91 a.a.) for Ob-Ra shared 90 and 80% similarity with the human and rat Ob-Ra, respectively. The widespread tissue distribution of Ob-Rb in the growing heifer suggests that leptin may potentially have a direct action on peripheral tissues. Immunocytochemical staining of bovine mammary epithelial cells and MAC-T cells using a specific antibody to Ob-R revealed that Ob-R protein is also expressed in bovine mammary parenchyma. The presence of Ob-Rb mRNA and Ob-R protein in the mammary gland supports the concept that leptin may play a direct role in mammary parenchymal development.

Key Words: Leptin receptor, Mammary, Heifer

934 Postnatal nutrition and fatness affect plasma leptin concentration in neonatal sheep. R.A. Ehrhardt¹, P.L. Greenwood^{*2}, R.M. Slepatis¹, A.W. Bell¹, and Y.R. Boisclair¹, ¹Cornell University, Ithaca, NY, ²NSW Agriculture Beef Industry Centre, Armidale, NSW, Australia.

Effects of birth weight and postnatal nutrition on plasma leptin concentration were investigated in male Suffolk x (Finn x Dorset) lambs from birth to LW 20 kg. Lambs of low (meanSD 2.290.34 kg, n=28) and high (4.840.45 kg, n=20) birth weight were individually fed a milk replacer diet in amounts that promoted rapid (ad lib, ADG 350 g, n=20) or slower (restricted, ADG 150 g, n=20) growth, and slaughtered at selected LW from 5 to 20 kg. Blood plasma was obtained from selected lambs at birth, every second day from birth to slaughter, and during frequent

sampling one day prior to slaughter. At birth, plasma leptin concentration did not differ between low and high birth weight lambs (meanSEM 4.10.3 vs 3.80.3 ng/mL, respectively). During the first week of postnatal life, plasma leptin was higher in small compared to large newborns (4.10.1 vs 3.60.2 ng/mL, $P < 0.05$) and tended to be higher in ad lib compared to restricted fed lambs (4.10.2 vs 3.6 0.1 ng/mL, $P = 0.07$). By week 2 of postnatal life, plasma leptin was significantly higher in the ad lib group (4.60.2 vs 3.70.2 ng/mL, $P < 0.005$) but was not affected by birth weight. Overall, during rearing to 20 kg LW, plasma leptin concentration was greater in ad lib than restricted lambs ($P < 0.001$) but was not significantly affected by birth weight. The effect of plane of nutrition increased with LW; ad lib lambs had leptin concentrations that were twice those of restricted lambs at 15 kg LW (6.01.0 vs 3.10.2 ng/mL), and 3-times greater at 20 kg LW (8.20.5 vs 2.80.2 ng/mL). Although plasma leptin concentration was related to both mass of body fat ($r = 0.614$, $P < 0.001$) and percentage of body fat ($r = .624$, $P < 0.001$), body fatness was not sufficient to explain the effect of plane of nutrition. This was particularly evident as the lambs reached 20 kg LW, when ad lib lambs were only 16% greater in body fatness than restricted lambs yet had plasma leptin concentrations that were 3 times greater than restricted lambs. Collectively, these data suggest that plane of nutrition independent of its effect on body fatness, is a major factor regulating plasma leptin concentration during early postnatal growth in sheep.

Key Words: lambs, nutrition, leptin

935 Effects of dietary protein and weaning age on hormone and metabolite concentrations in neonatal dairy calves. C. C. Williams^{*1}, D. L. Thompson, Jr.¹, H. G. Bateman, II¹, B. F. Jenny¹, D. T. Gantt¹, L. R. Gentry¹, G. E. Goodier¹, and C. M. Cheatham¹, ¹LSU Agricultural Center.

The objective of this study was to investigate effects of starter crude protein (CP) level and weaning regimen on metabolic hormone and glucose concentrations in neonatal dairy calves through 10 weeks of age. Twenty four Holstein ($n = 12$ male and 12 female) calves were assigned to one of four treatments in a 2×2 factorial arrangement consisting of 2 calf starters (16% vs. 22% CP, as-fed basis) and 2 weaning ages (4 or 8 weeks). Calves received colostrum for 3 days and then milk replacer (22% CP, 15% fat) until weaning. Milk replacer was fed at 10% of birth weight divided into 2 feedings daily until 2 weeks prior to weaning. Then replacer was reduced to 75% of original amount and fed once daily and further reduced to 50% of original amount one week prior to weaning. Beginning on day 4 calves were allowed free access to calf starter. Blood samples were collected weekly from weeks 1 through 10 prior to and 2 hours after the morning feeding. Pre-feeding samples were analyzed for insulin-like growth factor-I (IGF-I), insulin, glucagon, and glucose, while post-feeding samples were analyzed for insulin and glucose. At 2 week intervals, blood samples were collected every 15 minutes for 7.5 hours for determination of growth hormone (GH). Concentrations of plasma GH, IGF-I, insulin, glucagon, and glucose were not affected by starter CP level ($P > 0.05$). Mean plasma GH concentrations tended to be greater ($P = 0.09$) in calves weaned at 8 weeks. Plasma IGF-I concentrations increased with age ($P < 0.01$) but were not influenced by weaning regimen ($P > 0.05$). Plasma glucagon concentrations decreased with age ($P < 0.01$) and were lower in calves weaned at 8 weeks ($P < 0.05$). Glucose concentrations were greater in calves weaned at 8 weeks ($P < 0.01$). There was an interaction of weaning age by week by time relative to feeding for concentrations of insulin ($P < 0.01$) and glucose ($P < 0.05$). Post-feeding concentrations of insulin and glucose increased weekly until weaning. After weaning, concentrations of insulin and glucose, regardless of sampling time, decreased until the end of the 10 week study. While starter crude protein level did not affect hormone or metabolite concentrations, age related changes were evident in these metabolic parameters in developing neonatal calves.

Key Words: Dairy calves, Hormones, Metabolites

936 Thyrotropin releasing hormone (TRH) mediates serotonin-induced release of growth hormone. R. P. Radcliff^{*}, L. T. Chapin, K. J. Lookingland, and H. A. Tucker, Michigan State University, East Lansing, MI.

The serotonin receptor agonist, quipazine, induces secretion of growth hormone (GH) in cattle, but the mediator of this response is not known. We hypothesize that TRH mediates serotonin-induced secretion of GH. Holstein steers were injected daily with 3,3',5-triiodo-L-thyronine (T_3) dissolved in corn oil ($n=8$) to induce negative feedback on the thyrotropic axis, thereby decreasing TRH receptor expression on the anterior pituitary gland and/or TRH synthesis in the hypothalamus. Controls ($n=8$) received corn oil. Blood was collected at 20-min intervals for 6 h on days -1, 5 and 10 relative to initiation of injections to quantify basal secretion of GH. After 20 d of injections, steers were challenged every other day with an i.v. injection of growth hormone-releasing hormone (GHRH), TRH, quipazine or vehicle. Blood was collected at -60, -40, -20, 0, 5, 10, 15, 20, 30, 40 and 60 min relative to i.v. challenge and serum assayed for GH. Compared with corn oil, T_3 did not affect basal concentrations of GH in serum. As expected, GHRH increased area under the response curve (AUC) of GH similarly in corn oil- and T_3 -treated steers. Compared with vehicle, TRH increased AUC of GH in corn oil-treated (386 vs 873 \pm 95 ng \cdot ml⁻¹ min; $P > 0.01$) but not T_3 -treated steers (294 vs 609 \pm 101; ng \cdot ml⁻¹ min; $P > 0.1$). However, TRH induced AUC of GH in T_3 -treated steers was intermediate between T_3 -treated steers that received vehicle and corn oil-treated steers that received TRH. Similarly, compared with vehicle, quipazine increased AUC of GH in corn oil-treated 413 vs 1169 \pm 181 ng \cdot ml⁻¹ min; $P < 0.01$) but not T_3 -treated steers (340 vs 601 \pm 198 ng \cdot ml⁻¹ min; $P > 0.5$). Like TRH, quipazine induced AUC of GH in T_3 -treated steers was intermediate between T_3 -treated steers that received vehicle and corn oil-treated steers that received quipazine. Thus, injections of T_3 reduce but do not completely block TRH- and serotonin receptor agonist-induced secretion of GH. In conclusion, TRH mediates, in part, serotonin-induced secretion of GH in cattle.

Key Words: Cattle, Hyperthyroidism, Serotonin, Growth hormone

937 The effect of photoperiod on hepatic Growth Hormone receptor (GHR) expression in steer calves. P. E. Kendall^{*1}, T. L. Auchtung¹, K. S. Swanson¹, M. L. Bode², M. C. Lucy², J. K. Drackley¹, and G. E. Dahl¹, ¹University of Illinois, Urbana, IL, ²University of Missouri, Columbia, MO.

Photoperiod manipulation, specifically long days (LDPP), increases milk production in lactating cattle. We have previously reported that the galactopoietic effect of LDPP is associated with an increase in circulating insulin-like growth factor-I (IGF-I), which occurs independent of changes in IGF binding proteins and GH concentrations. This study tests the hypothesis that LDPP increases the expression of GHR 1A mRNA in the liver. Two groups of Holstein steers (98 \pm 4 days old) were maintained indoors and exposed to LDPP (16L:8D; $n=6$) or short day photoperiod (SDPP) (8L:16D; $n=6$) for a total of 9 weeks. The calves were fed individual rations of a grain- and alfalfa-based diet, which were adjusted for live weight. Jugular blood samples were collected at weekly intervals to determine changes in serum IGF-I by radioimmunoassay. Liver biopsies were obtained at 3-week intervals to quantify changes in hepatic GHR 1A mRNA using real time polymerase chain reaction on an ABI PRISM 7700[®] Sequence Detection System. Steer live weight increased during the study but did not differ between treatments, nor were differences in feed consumption found. Despite the variation within treatments, there was a tendency for the amount of GHR 1A mRNA to be higher ($P=0.08$) in LDPP steers on day 39 relative to SDPP steers. This would be consistent with the hypothesis that liver GHR 1A mRNA is correlated with circulating IGF-I concentrations. We conclude that changes in IGF-I secretion in LDPP cattle could be regulated by an increase in GHR 1A, but that the endocrine pathway whereby LDPP influences GHR expression remains to be elucidated.

Key Words: Cattle, Photoperiod, Growth Hormone receptor

938 Constraints on reproductive performance of indigenous cows under small holder village farming system in Bangladesh. M. Samad Khan*, *Bangladesh Agricultural University, Mymensingh.*

Indigenous cows were studied to find out the reproductive constraints under village condition of Bangladesh. Sixty seven postpartum cows were taken from 65 small holder farmers. Selected animals were used for dairy/draught purpose. Cows were supplied with rice straw based diet. Calves were allowed to free access for suckling cows during day and were tied up at night. Cows were milked once a day in the morning. Metabolic kits supplied by the Food and Agriculture Organization of the United Nations/ International Atomic Energy Agency (FAO/IAEA) were used for metabolic profile study and FAO/IAEA Radioimmunoassay (RIA) kits were used for progesterone (P4) measurement. Calving to first ovulation were calculated on the basis of first P4 rise in milk. Reproductive events were measured. Data were analyzed by 4 seasons to find out the reproductive constraints of indigenous cows. The plasma urea values (mmol/L) of the cows were 4.5, 7.2, 5.5 and 3.2 for the seasons Summer, Autumn, Winter and Spring respectively. The calving to first ovulation were 66, 67, 187 and 51 days; to first service were 272, 120, 191 and 216 days; to first conception were 263, 136, 197 and 223 days; and calving interval were 544, 419, 489 and 501 days for the seasons Summer, Autumn, Winter and Spring respectively. Among the blood metabolites studied, a considerable change in urea values were noticed. It represents an important nutritional constraints on reproduction. The Spring values were lower enough to suggest a shortage of Rumen Degradable Protein (RDP) in the ration. The calving to first service was higher than that of calving to first ovulation, that means farmers were unable to detect heat of their cows. So, heat detection was a constraint to the reproduction of indigenous cows. The calving to first service in the Autumn was much better than that in the other 3 seasons. It would be tempting to relate to the urea levels that were the highest in the Autumn. From this study two important constraints of reproduction has been identified for the indigenous cows where interventions are needed, (1) Nutritional constraints in general, mainly protein, during the Spring season and (2) Lack of knowledge of estrus detection by the farmers during the early part of lactation.

Key Words: Indigenous, Progesterone, Protein

939 True estrus determination through evaluation of serum-progesterone levels at the time of insemination of dairy cows from semi-intensive dairies in north-central Mexico. EF Ricoy¹, C Acua, RM Rincon, DF Cortes, R Bauelos-Valenzuela, and CF Arechiga*, ¹*Universidad Autonoma de Zacatecas, Zacatecas, Mexico.*

The purpose of this study was to determine which proportion of cows bred by artificial insemination (n=103), at semi-intensive dairies from north-central Mexico (La Fresnille, Zacatecas, Mexico), presented a true estrus at the time of insemination. Criteria for detection of a true estrus was based on serum-progesterone levels measured by radioimmunoassay. A blood sample was collected from tail-vein via venipuncture and serum was separated. Serum-progesterone levels lower than 1 ng/ml indicated the presence of the follicular phase of the estrous cycle and possibly the presence of a true estrus (i.e., heat); and, serum-progesterone levels greater than 1 ng/ml confirmed the presence of a luteal phase of the estrous cycle and a total absence of estrus. Results have shown that 23.3% (24/103) of inseminated cows had serum-progesterone levels above 1 ng/ml indicating the total absence of estrus (P<0.001). Thus, only 76.7% (79/103) had a chance to be in estrus or around it. Cows with serum-progesterone levels above 1 ng/ml (follicular phase) had an average of 0.092 ng/ml; whereas, cows with serum-progesterone levels above 1 ng/ml (luteal phase) had an average of 1.070 ng/ml. These results confirmed serious management problems at those dairies on estrous detection and insemination criteria that could compromise fertility, semen costs, and genetic improvement at the dairy.

Key Words: estrus, dairy cow, Mexico

940 Effect of a reduced dose of GnRH (50 µg) in a timed AI protocol used for Holstein cows from an intensive dairy at north-central Mexico. OI Gutierrez¹, RD Gonzalez¹, RR Lozano², F de la Colina¹, R Bauelos¹, E Gonzalez-Padilla², and CF Arechiga*¹, ¹*Universidad Autonoma de Zacatecas, Zacatecas, Mexico.*, ²*Universidad Nacional Autonoma de Mexico, Mexico.*

Present study try to determine whether a reduced dose of GnRH (i.e., 50 vs. 100 µg) in a timed AI protocol (TAI) [d 0, GnRH; d 7, PGF2α; d 9, GnRH; d 10, TAI] was effective increasing pregnancy rates of dairy cows (Aguascalientes, Mexico). Dairy cows (n=120), 45 to 90 d postpartum (PP), from 1 to 7 parities, an average body condition score of 3.28, an milk yield of 25-28 kg/d (3x), were randomly assigned into two groups: 1) Control (100 µg GnRH in a TAI protocol). 2) Treated (50 µg GnRH in a TAI protocol). There were no differences in pregnancy rates to first service [19.17% (23/120) vs. 25.00% (30/120)], neither at 150 d PP [28.33% (34/120) vs. 27.50% (33/120)] or intermediate periods (60, 90, 120 d PP). There were no differences in the intervals from calving to first service and to conception; neither in services per conception. A greater proportion of cows tended to become pregnant when a medium or large follicle (10 and 15 mm, respectively), was present in the ovary at the beginning of the TAI protocol or with cows of lower milk yield (3,500-7,500 kg). A reduced dose of GnRH, reduces cost of TAI by \$5.3 dollars, and cost of TAI for pregnant cows at first service by \$17.1 dollars. In conclusion, a reduced dose of GnRH was effective to synchronize ovulation without affecting reproductive parameters. Such a lower input will allow to disseminate the use of timed AI protocols in dairy cows from developing countries.

Key Words: dairy cow, timed AI, Mexico

941 Serum-progesterone measurements to determine age at puberty and luteal function in hair sheep from a semi-arid region in north-central Mexico. A Gutierrez, W Gonzalez, RM Rincon, O Perez-Veyna, R Bauelos-Valenzuela, and CF Arechiga*, ¹*Universidad Autonoma de Zacatecas, Zacatecas, Mexico.*

Serum-progesterone measurements were performed by radioimmunoassay to determine luteal activity (i.e., greater than 1 ng/ml), maintenance of luteal function and age at the onset of puberty in hair sheep (n=17; Pelibuey Sheep) exposed to a semi-arid environment. Ewes had an average weight of 1.98 ± 0.03 at birth, and just before the six-months of age (175-185 d), they were transported to a semi-arid environment where the experiment took place, which included twice weekly determinations of serum-progesterone levels throughout 110 d. By the end of the experiment when ewes had 285 d of age and an average body-weight of 18.87 ± 0.17 kg, results have shown that 53% (i.e., 9 of 17 ewes) had serum-progesterone levels greater than 1 ng/ml at least once throughout the experimental period. But only 29% (i.e., 5 of 17 ewes) maintained luteal activity similar to an estrous-cycle pattern of progesterone secretion. Serum-progesterone levels increased significantly by the end of the experiment (P<0.05) and were correlated with body-weight increases throughout the experiment and decreased light-hours during the day (P<0.05). Average progesterone levels were 0.29 ± 0.05 ng/ml. Average daily gain was 0.080-0.150 kg/d from 0 to 285 d of age; and 0.050-0.057 kg/d from 175 to 285 d of age. In conclusion, onset of puberty in hair sheep at semi-arid regions seems to be influenced by increases in body weight and a reduction in light-hours during the day (i.e., below 12 light-hours during the day).

Key Words: Hair Sheep, Photoperiod, Mexico

942 Nutrient digestibility and nitrogen balance of growing Zimbabwean Mukota, Large White and their F1 crosses fed on diets containing graded levels of maize cobs. A.T. Kanengoni, K. Dzama*, M. Chimonyo, J. Kusina, and E. Bhebhe, *University of Zimbabwe, Harare, Zimbabwe.*

A study was conducted to compare the digestibility of organic matter (OM), neutral detergent fibre (NDF), acid detergent fibre (ADF), nitrogen (N) and hemicellulose and nitrogen balance in Zimbabwean Mukota, Large White (LW) and their F1 crosses. Four male pigs of each breed, selected at 30 percent of their mature live weights, were sequentially allocated to each of four diets. The diets, which were formulated to contain similar levels of protein (ca. 160g CP/kg) and energy (ca. 9MJ ME/kg),

contained 0, 100, 200 and 300g maize cobs/kg. There was a negative correlation ($P < 0.001$) between the digestibility of the nutrients and the level of NDF in the diet. There was a linear decrease ($P < 0.05$) in the digestibility of OM, ADF and hemicellulose with increase in the level of fibre among all the breeds. The OM, ADF and hemicellulose digestibilities, however, decreased faster ($P < 0.05$) in the LW than in the Mukota and F1 crosses as the level of maize cobs increased. Both breed and level of maize cobs had no effect on N digestibility, N retained per metabolic body weight and N retained per nitrogen intake ($P > 0.05$). The findings showed that the Mukota and the F1 crosses were better able to digest the fibrous components than the LW. In addition, the Mukota and F1 crosses displayed an ability to retain protein to the same extent as the LW.

Key Words: Zimbabwean Mukota, Nitrogen balance, Digestibility

943 Present Status of the Heifer Project International-Cameroon Rabbit Program. S. D. Lukefahr*¹, H. I. Nkwocha², H. Njaki², E. Tawah², J. M. Akob², F. A. Kongyu², and D. Gudahl³, ¹Texas A&M Univ.-Kingsville, ²Heifer Project International, Bamenda, Cameroon, ³Heifer Project International, Little Rock, AR.

In the past five years, Heifer Project International (HPI) has distributed a minimum of 2,119 rabbits to 1,410 limited-resource families in 66 villages primarily located in the northwest province of Cameroon. However, these figures exclude thousands of additional farmers who received either direct or indirect assistance by HPI since project inception in 1982. HPI's approach towards poverty alleviation is to financially support a new rabbit project for farm families in a selected village for a period of three years. Technical follow-up support is then extended for an additional two years, after which time the anticipated self-sufficient project is formally phased-out. In 1999, accompanied by HPI field staff, the consultant (the first author of this abstract) visited a total of 48 farmers from 9 villages in the northwest province. On each farm, notes were taken which identified poor to good management-level practices, housing and feeding systems, as well as socio-economic aspects of the project. HPI progress reports and case studies conducted by student interns from University of Dschang were made available to supplement the consultant's notes in developing an evaluation report. Overall, production level of rabbit fryers presently appears to be low on farms (approximately 2.45 fryers are consumed and 2.61 fryers are sold per month). Further, income generation is a critical determinant of whether rabbits will continue to be regarded by farmers as a backyard livestock species for domestic use or as a commodity species for supplemental income. HPI could play a pivotal role in developing either local or formal market outlets for their surplus fryers. To date, the HPI-CAM rabbit program has improved family nutrition, enhanced community development and gender status in villages.

Key Words: Rabbits, International Programs, Development

944 Effects of World Bank prescribed economic structural adjustment on poultry production in Nigeria and policy suggestions for the improvement of the sector. A. A. Onifade*¹, F. A. Nasiru², O.T.F. Abanikanda¹, and F. Kudah², ¹Department of Animal Science, University of Ibadan, ²Michael Stevens & Associates, 1 Tokan Street, Western Avenue, Surulere, P. O. Box 528, Apapa, Lagos.

The World Bank advised the Nigerian Government to undertake structural adjustment (SAP) of the economy, and this was commenced in June 1986 and remained until early 1990. The economic reforms involved policy reforms such as exchange rate deregulation, trade reforms, tariffs restructuring, all of which affected the macroeconomic variables such

as inflation, interest rate, employment. A nationwide study was carried out to obtain primary data using stratified random questionnaire administration and structured interviews of small-scale and organized poultry farmers, and officials of Government livestock Departments. Additional data were sourced from secondary sources. The depreciation of the Nigerian currency caused spiraling inflation and volatile interest rates, which made cost of livestock inputs especially the imported components such as feed ingredients and medicaments to soar, access to credits became difficult, producer prices rose significantly, capacity utilization and demand for animal products fell drastically, and a general decline in poultry production was noticed from 1986. The ban on importation of corn and barley caused distortion in animal feed production and led to widespread closures of poultry production facilities. There was intra-sectoral shift with more farmers moved into egg production and meat-type poultry production was targeted at festivals. There was increased utilization of alternative feedstuffs especially by-products of oil mills and tuber processing. The establishment of private veterinary services increased, but farmers complained of low-quality services and products. Quality of feedstuffs and finished feeds in the market decreased forcing most medium producers to integrate feedmilling into their production. In conclusion, the economic adjustment in the main negatively impacts on poultry production, there was policy misjudgment in banning of corn, but increased utilization of alternative feedstuffs; increased custom feedmilling, vertical integration and intra-sectoral shifts and increased accessibility to veterinary services were recorded. Policy suggestions favored concretization of national policies on poultry production, nutrition, health, research and extension.

Key Words: Economic Adjustment Program, Poultry Production, Policy Suggestions

945 Comparing the economic power of the populations of European Community (EC) and North American Treaty Countries (NAT)-1999-2010, using per adult human unit (PAHU) versus per capita (PC). S. Hasimoglu*¹, ¹Continental Analytical Services Inc., Salina, KS.

At the beginning of the new millennium EC and NAT countries became strong economic competitors. As the 15-nation EC expands during the next 10 years, competition will continue to increase. The data gathered to evaluate food production and consumption has traditionally been presented on PC basis. The use of "per capita" rarely has been challenged. Presentation of the alternative PAHU system will, however, show "per capita" as inherently erroneous. The PAHU calculation method and obtained conversion factors for the age groups showed a 21.76 percentage units (PU) difference from PC calculations in the under 20-year-old age group in equally populated developed and developing countries. PC evaluation disregards not only the younger, but also the older portions of populations. The calculated, unintended, fault level is not less than 15.86 PU when compared to PAHU. In 1999, three NAT countries had 405 million PC population, calculated as 329 million PAHU. These three countries will reach 451 million PC, or 374 million PAHU in the year 2010. In 1999 NAT had 31 and 12 million higher PC and PAHU than EC countries respectively. EC (15-nation) during same time of period will have 374 million PC, or 317 million PAHU. Since EC going to expand in the next ten years to include 11 new applicant countries (an addition of 159 million PC, or 134 million PAHU), it will reach 533 million PC, or 445 million PAHU inhabitants. Planned as an integrated economic area with a single currency, it will be the largest organized agricultural trading, production and consumption power in the world. Since PAHU replaces the word "predict" with "measure", it will not only help better redesign economic relationships throughout the world, it will influence national and international direction of obtaining precise food consumption/production measurements aimed to create a nutrition monitoring system that will standardize all nutrition intake reporting done by various agencies of both developed and developing countries.

ASAS/ADSA Physiology: Male Physiology/Conceptus Development and Survival

946 The History of Artificial Insemination: Founders and Facts. R.H. Foote*, Cornell University.

This overview will cover briefly the relevant knowledge existing when intensive studies on artificial insemination (AI) began, the problems faced, and how these were overcome. Also, some of the people who made it happen will be identified. Emphasis will be on dairy cattle, but also

beef cattle, swine, horses, sheep, goats, poultry, laboratory animals, and endangered species will be included. There are many steps that are important in AI so that maximal fertility will result when sperm are transferred from the male at one time and place to a female in estrus elsewhere. These steps include: 1) understanding and exploiting each bull's sexual behavior; 2) providing an optimal schedule and place

for semen collection; 3) using the most reliable equipment for collecting and processing semen; 4) using objective methods for evaluating semen; 5) providing optimal semen extenders and procedures for sperm preservation; 6) adopting procedures to insure protected distribution and storage of semen in the field; 7) and skillful insemination of cows properly selected for the right time to inseminate. With modification of these procedures the principles apply to all species. New methods for accurate evaluation of the genetic worth of the males selected for use in AI were needed and developed. Resistance by elements of the public to "meddling with nature", and by cattle breeders in competition for the sale of bulls, had to be overcome. But eventually AI was accepted as the greatest biotechnology ever developed and applied for the control of venereal diseases and the genetic improvement of dairy cattle. The acceptance of AI laid the foundation and opened opportunities for subsequent development of synchronized estrus, embryo transfer, sexed semen, and even cloning. Conventional AI will continue to benefit animal agriculture and human welfare as it moves into the 21st century of genomics, with marker assisted selection and genetic engineering.

Key Words: Artificial Insemination, Domestic Animals, Biotechnology

947 Effect of capacitation environment of spermatozoa on fertilization of porcine oocytes in vitro. J.M. Popwell¹ and W.L. Flowers*¹, ¹North Carolina State University.

The objective of this study was to examine the effect of the capacitation environment of porcine spermatozoa on their ability to fertilize oocytes in vitro. Semen was collected from 4 boars and processed for either in vivo or in vitro capacitation. For in vivo capacitation, 50 mL of neat semen containing 20 billion spermatozoa was used for insemination (n=18 gilts/boar). Between 6 and 16 h after insemination, uterine horns and oviducts were flushed and spermatozoa recovered from each location were classified as being exposed to a unique capacitation environment. For in vitro capacitation, the remainder of each ejaculate was washed and incubated in media for an equivalent length of time. Spermatozoa (200/oocyte) from each environment (oviduct, uterus, and in vitro) were used to fertilize oocytes (n=200/environment) in vitro. Chlortetracycline staining also was used to assess the capacitation status of spermatozoa at the time of fertilization. Boar A (15.3+/-4.7%) had fewer (P<.05) capacitated spermatozoa than boars C (32.7+/-6.7%) and D (42.1+/-6.8%). The capacitation status of sperm cells from boar B (28.1+/-9.2%) was similar (P>.15) to that observed for the other boars. In contrast, boar B (14.7+/-1.4%) produced higher (P<.05) monospermic fertilization rates in vitro than boars A (10.0+/-1.5%) and C (6.2+/-2.1%). Sperm cells from boar D (12.3+/-1.7%) fertilized more (P<.05) oocytes than those from boar C. A greater proportion (P<.05) of capacitated spermatozoa were present in vitro (40.7+/-7.1%) and in the oviducts (52.2+/-7.1%) than in the uterus (18.3+/-6.2%). However, there was no difference (P=.27) in the ability of spermatozoa from the oviductal (12.3+/-2.0%), uterine (8.7+/-2.1%), or in vitro (9.8+/-1.8%) environments to fertilize oocytes. In summary, capacitation environments of spermatozoa did not influence monospermic fertilization in vitro even though significant differences were present for the proportion of capacitated sperm cells in each environment.

Key Words: Spermatozoa, Fertilization, Swine

948 Apoptosis as a Mechanism of Germ Cell Loss in Yearling Stallions. N.L. Heninger*¹, C.L. Donnelly¹, C. Staub³, T.L. Blanchard², D.D. Varner², D.W. Forrest¹, and L. Johnson³, ¹Texas A&M Dept. of Animal Science, ²Texas A&M Dept of Veterinary Large Animal Medicine and Surgery, ³Texas A&M Dept of Veterinary Anatomy and Public Health.

In an effort to determine whether germ cell loss occurs via apoptotic mechanisms during the development of spermatogenesis, 22 testicles from 17 yearling stallions with normally developing testes (ages 11-15 mo) were weighed, cross-sectioned, fixed in 4 % paraformaldehyde, and set in paraffin. Immunohistochemical apoptotic detection was performed on 5mm sections mounted on glass slides using Apoptag peroxidase detection kit S7100 (Intergen, Purchase, NY). Tissue sections were deparaffinized and free 3-OH ends labeled (TUNEL) in situ by direct immunoperoxidase detection of digoxigenin labeled DNA. Sections were counterstained with methyl green. Two evaluators counted the total number of apoptotic cells in 50 round seminiferous tubules from both light and dark parenchyma within a single section. The frequency of tubules containing at least one apoptotic cell, as well as tubule diameter were also recorded. Light and dark tissue was classified according to

lumen score (1-5) as described in previous research. Lumen scores of 1-2 were obtained for dark parenchyma, and 3-4 for light parenchyma. No stage 5 tubules (the most mature) were seen for these young animals. More apoptotic cells per tubule were detected (P < 0.001) in light tissue (0.5 ± 0.01) when compared to dark tissue (0.06 ± 0.01). As tubule diameter increased, total number of apoptotic cells increased (r²= 0.70, P < 0.001). Light parenchyma contained a greater (P < 0.001) proportion of tubules with at least 1 apoptotic cell (23% ± 3%) when compared to dark parenchyma (5% ± 1%). It is clear that apoptosis is involved in normal progression of spermatogenesis as a means of removing germ cells from the seminiferous epithelium in pubertal stallions. Further research is needed to determine cell types typically undergoing apoptosis, as well as topographical trends in development of apoptosis during initiation of spermatogenesis.

Key Words: Apoptosis, Spermatogenesis, Stallion

949 Comparison of traits at sexual maturity of recently introduced breeds to Angus and Brahman bulls. S.R. Tatman*¹, C.C. Chase², D.A. Neuendorff¹, A.W. Lewis¹, T.W. Wilson¹, C.G. Brown¹, and R.D. Randel¹, ¹Texas Agricultural Research and Extension Center, Overton, TX 75684-0290, ²Subtropical Research Station, ARS, USDA, Brooksville, FL 34601-4672.

Reproductive development of Angus (A; n=7), Brahman (BR; n=10), Bonsmara (BO; n=8), Romosinuano (R; n=10), Tuli (T; n=14), and Wagyu (W; n=10) bulls was studied. All bulls were maintained together and fed a 3:1 (corn: soybean meal) supplement containing lasalocid. The supplement was fed at 1.5% BW with free access to coastal bermuda grass hay, water, and a salt/mineral mix. Measurements of reproductive development were taken at 14-d intervals until each bull reached sexual maturity (SM; ejaculate with at least 500 million sperm with at least 50% motility). Measurements included BW, body condition score (BCS), scrotal circumference (SC), and individual testis length. After reaching 21 cm SC, ejaculates were collected at 14-d intervals through SM via electroejaculation. Age at SM differed among breeds (P < 0.05) with BR the oldest (453±11 d), followed by A (417±13 d) and R (414±11 d) which did not differ (P > 0.10), and T (377±9 d), W (359±11 d), and BO (335±12 d). Age at SM in W and BO bulls did not differ (P > 0.10). BW at SM was greatest for BR (418±14 kg) and differed (P < 0.01) followed by A (350±16 kg), BO (336±15 kg), and R (330±13 kg). A vs T (308±11 kg) BW at SM was similar (P > 0.10) while W bulls were lightest (281±13 kg), yet similar (P > 0.10) to T. SC at SM was similar for (P > 0.10) BR (30.2±.9 cm), BO (30±.9cm), A (29.9±1 cm), R (28.5±.8 cm), and T (28.4±.7cm) while W bulls had the smallest (P < 0.05) SC at 25.9±.8 cm. A, BO and BR bulls had the greatest PTV at SM (448±36 cc, 426±33 cc, and 405±31 cc) and were similar (P > 0.10), followed by T (370±25 cc), R (351±30 cc), and W (286±30 cc). BR bulls were oldest and heaviest at SM followed by A in both categories. W bulls had the least BW, SC, and PTV at SM. Newly introduced breeds in this study performed competitively with A bulls in a subtropical environment and may play an important role in crossbreeding.

Key Words: Beef Breeds, bulls, sexual maturity

950 Comparison of adrenal and testis content of the steroidogenic acute regulatory (StAR) and P450 side-chain cleavage enzyme proteins in Angus, Brahman and Romosinuano bulls. J.W. Koch*^{1,2}, K.N. Livingston¹, S.R. Tatman², D. Alberts³, D.M. Stocco³, C.C. Chase, Jr.⁴, R.D. Randel², and T.H. Welsh, Jr.¹, ¹Texas Agricultural Experiment Station, College Station, TX, ²Overton, TX, ³Texas Tech University Health Sciences Center, Lubbock, TX, ⁴ARS, USDA, Brooksville, FL.

Whether breed influences adrenal and testis content of StAR and P450 proteins was studied by use of Angus (n=7; A), Brahman (n=8; B) and Romosinuano (n=10; R) bulls. Bulls were slaughtered 69-111 d after reaching sexual maturity. Adrenals and testes were collected at slaughter, trimmed and weighed. Western blot analyses were performed to compare StAR and P450 content based on integrated optical density units (IOD). B and R had similar adrenal gland weights (14.8±0.8; 14.9±0.7 g, respectively) which were less (P<.02) than A adrenal weight (17.7±0.7). Plasma cortisol was similar among breeds at slaughter (A, 11.9±2.9; B, 16.5±2.7; R, 18.3±2.6 ng/ml). Adrenal StAR protein was similar in A and R (.209±.010; .199±.008, respectively). B adrenal StAR (.0177±.009) was lower than A but not R adrenal StAR. Adrenal P450 did not differ among breeds. Adrenal StAR and P450 proteins

were not significantly correlated. Testis weight was greater ($P < .02$) in B (642.7 ± 32.6 g) than A (417.7 ± 34.8 g) and R (379.1 ± 29.2 g). Plasma testosterone at slaughter was similar among breeds (A, 3.0 ± 2.2 ; B, 2.5 ± 2.1 ; R, 6.7 ± 1.9 ng/ml). Testis StAR was lower ($P < .006$) in B ($.079 \pm .016$) than A ($.154 \pm .017$) and R ($.155 \pm .014$) bulls which did not differ from each other. Testis P450 was lower ($P < .02$) in B ($.012 \pm .006$) versus A ($.036 \pm .006$) bulls. Testis P450 in R ($.028 \pm .005$) did not differ from A or B bulls. Testis StAR was positively correlated with testis P450 ($r = .6$, $P < .003$) and testosterone at slaughter ($r = .4$, $P < .03$) but negatively correlated with testis weight ($r = -.6$, $P < .005$). Breedtype appeared to influence expression of proteins involved in adrenal and testicular steroidogenesis.

Key Words: Adrenal, Testis, StAR

951 Effects of castration on patterns of LH and testosterone and reproductive behavior in bulls. D.B. Imwalle and K.K. Schillo*, *University of Kentucky, Lexington KY.*

We tested the hypothesis that testosterone is required for maintaining reproductive behavior in sexually experienced bulls. Eighteen yearling bulls were divided randomly into three treatment groups: intact (I); castrated (C); castrated + testosterone (T). All bulls were subjected to libido tests one week before and weekly for four weeks after castration to quantify mounting activity and flehmen responses. Patterns of LH and testosterone were also assessed at these times. One week before castration, concentrations of testosterone, concentrations of LH and frequencies of LH pulses were not different among treatment groups. In the C group, concentrations of testosterone decreased ($P = .01$) to non-detectable levels by one week following castration. During this time, concentrations of testosterone did not change in the I group and increased ($P = .003$) in the T group. Throughout the post-castration period, concentrations of testosterone were higher ($P = .001$) in T bulls than in I or C bulls, and concentrations of testosterone in I bulls were higher ($P = .02$) than in C bulls. Mean concentrations of LH and LH pulse frequencies increased ($P < .001$) between one week before and one week after castration in C animals, but did not change in I or T animals during this time. During the post-castration period, LH concentrations and LH pulse frequencies were higher ($P < .001$) in C bulls than in the I and T bulls, but neither of these variables differed between the I and T groups. Mounting activity decreased ($P = .05$) in all groups between one week before and one week after castration. Thereafter, mounting activity increased ($P = .001$) in each group and reached pre-castration levels by the end of the experiment. At no time during the post-castration period did mounting activity differ among treatment groups. Number of flehmen responses did not differ among groups before castration. However, after castration, C bulls consistently showed fewer ($P = .04$) flehmen responses than I and T bulls. In conclusion, testosterone does not appear to be required to maintain mounting activity in adult bulls. However, testosterone may be important in regulating flehmen responses.

Key Words: LH, Testosterone, Masculine behavior

952 Evaluation of somatotrophic axis gene expression and function in Angus, Romosinuano, and Brahman bulls. T. A. Strauch*^{1,2}, J. W. Koch^{1,2}, S. R. Tatman^{1,2}, C. C. Chase, Jr.³, C. A. Abbey¹, T. M. Bryan¹, R. D. Randel², and T. H. Welsh, Jr.¹, ¹Texas Agricultural Experiment Station, College Station, ²and Overton, TX, ³Subtropical Agricultural Research Station, ARS, USDA, Brooksville, FL.

Whether genotype influences somatotrophic gene expression and function in temperate *Bos taurus* (Angus; A), tropically adapted *Bos taurus* (Romosinuano; R), and tropically adapted *Bos indicus* (Brahman; B) bulls was evaluated. Growth rate, anterior pituitary expression of growth hormone (GH) mRNA, liver expression of mRNA for exon 1A of the GH receptor (GH1A) and IGF-I, and plasma IGF-I concentrations in postpuberal A ($n = 10$), R ($n = 10$), and B ($n = 8$) bulls were determined. Pituitary and liver tissues were collected for mRNA analysis and blood was collected for analysis of plasma IGF-I concentrations by IRMA. GH mRNA expression in the anterior pituitary gland, and GH1A and IGF-I mRNA expression in the liver were determined via ribonuclease protection assays and quantified via integrated optical density units (IOD). There was a difference ($P < .008$) among breeds in ADG with A bulls having increased ADG as compared to B and R bulls (.98, .83, and .82 kg/d; A, R, and B, respectively; $SE = .04$). There was no difference ($P = .45$) in mRNA expression of GH among breeds; however, GH1A

mRNA expression did differ among bull breeds with B bulls having the lowest expression ($P < .006$; $.0002 \pm .05$, $.195 \pm .04$, and $.24 \pm .04$ IOD; B, R, and A, respectively). B bulls had higher IGF-I mRNA expression than R or A bulls ($P < .0001$; $2.11 \pm .22$, $1.1 \pm .18$, and $.66 \pm .18$, and IOD; B, R, and A, respectively). Plasma IGF-I concentrations were highest in R bulls both preslaughter ($P < .001$; 380.2 ± 26.3 , 277.1 ± 29.9 , and 212.2 ± 29.9 ng/ml; R, B, and A, respectively) and postslaughter ($P < .0001$; 433.6 ± 28.6 , 365.8 ± 30.3 , and 178.4 ± 27.1 ng/ml; R, B, and A). This suggests that breeds differ in somatotrophic gene expression and function, with tropically-adapted *Bos taurus* bulls being more similar to *Bos indicus* bulls than to temperate *Bos taurus* bulls.

Key Words: Somatotrophic axis, *Bos taurus*, *Bos indicus*

953 Embryonic mortality from the embryo's perspective. PJ Hansen, *University of Florida.*

For the embryo to successfully complete the preimplantation period, it must be capable of executing its developmental program within a microenvironment largely established by the mother. Mortality results either because of intrinsic defects within the embryo, an inadequate maternal environment, asynchrony between embryo and mother, or failure of the mother to respond appropriately to embryonic signals. To some extent, the embryo's fate is dictated by events before fertilization since embryos formed from incompetent oocytes have a low probability of successful development. For example, embryos have reduced developmental competence when formed from oocytes from persistent ovarian follicles or from cows in the summer in Florida. Chromosomal abnormalities, caused by incompetent oocytes or other causes, represent additional types of intrinsic errors responsible for embryonic loss. Alterations in the maternal environment can cause embryonic mortality as has been shown for heat stress, low maternal progesterone secretion, and feeding diets high in degradable protein. The preimplantation embryo is most susceptible to certain types of stresses (for example, heat shock and arsenic exposure) very early in development. At the earliest stages of development, the embryo is distinct from most cells in that its genome is largely repressed. Thus, the cellular adjustments the early embryo can make in response to perturbations in its environment are limited. Some genes related to resistance to cellular stress can become activated very early in development while other molecular responses to stress are absent. For example, heat shock can induce transcription of the heat shock protein 70 gene in the bovine embryo at the 2-cell stage even though general embryonic genome activation occurs at the late 4-cell and 8-cell stage. In contrast, the early bovine embryo cannot undergo apoptosis in response to cellular stresses that ordinarily activate this process. One possibility is that the acquisition of the capacity for apoptosis represents an important mechanism by which an embryo acquires the ability to survive cellular stress.

Key Words: Embryonic mortality, Embryo

954 The influence of uterine function on embryonic and fetal survival. J. L. Vallet*, *USDA, ARS, RLH US Meat Animal Research Center, Clay Center, NE, USA.*

The secretion rate of growth factors and the delivery rate of nutrients by the uterus affects the growth rate, development and survival of the conceptus. For most growth factors and nutrients, passage into the uterus is not simply controlled by diffusion. Many growth factors are products of uterine tissue. Transport of some nutrients is aided by specific transporter molecules on the uterine endometrial epithelial cell, while others (e.g., retinol, iron, folate) are incorporated into uterine secreted proteins (e.g., retinol binding protein, uteroferrin, folate binding protein). The rate of production of these proteins during pregnancy profoundly affects pregnancy outcome. Uterine gland knockout experiments in sheep demonstrate that pregnancy fails in the absence of uterine glands. In pigs, both global and specific effects of uterine products on aspects of conceptus development can influence litter size. The provision of growth factors and nutrients by the uterus plays a role in entraining conceptus development, so that the uterine environment and the developmental stage of the conceptus match. This uterine dependent control of conceptus development influences pregnancy success. For example, the uterus of the Meishan pig secretes less protein prior to elongation, which slows conceptus development, results in smaller placentas and smaller fetuses, and allows for greater litter size. Furthermore, in Occidental pig breeds, an earlier rise in progesterone at the beginning of pregnancy accelerates

the onset of protein secretion, increases estrogen secretion by the conceptus, increases the size of the fetus in later pregnancy, and decreases litter size. Studies of fetal erythropoiesis also indicate that specific uterine products (uteroferrin, folate binding protein) are required for this important aspect of fetal development and that greater litter size is associated with improved erythropoiesis. Thus, manipulation of uterine function can modify conceptus development and impact pregnancy success in domestic livestock.

Key Words: Pregnancy, Uterus, Conceptus

955 Role of placental function in mediating conceptus growth and survival. M. E. Wilson*, *West Virginia University.*

Conceptus mortality is a significant factor limiting reproductive efficiency of livestock. In both singlet (i.e., cattle) and litter (i.e., pigs and sheep) bearing species, investigations of conceptus mortality have traditionally focused on the period immediately preceding and throughout the attachment phase, around the time of maternal recognition of pregnancy. Recently, data has emerged leading to the suggestion that conceptus loss later in gestation is also significant and that variation in placental size and function may play a very important part in determining whether or not a conceptus survives. In the pig, the number of

conceptuses present after the initial period of loss that survive to term appears to be influenced by the total amount of placental mass present, such that litters containing individuals with relatively small placentae have a greater potential for a large litter size when compared to litters containing similar numbers of individuals with relatively large placentae. In ruminants, recent evidence supports the time of placental development and initial vascularization (between d 28 and 40) as a second period of significant loss, particularly in situations involving manipulation (ovulation synchronization for timed AI in cattle and out-of-season breeding in sheep). In the pig, not only does placental size vary, but the efficiency (as measured by the fetal wt to placental wt ratio) can vary as much as 3-fold within a litter, leading to the suggestion that selection for small very efficient placentae may provide a mechanism for increasing litter size. In ruminants, there are obvious cases where placental growth has been markedly altered (i.e., large offspring syndrome or heat stress) and a subsequent deviation from 'normal' placental efficiency occurs. Less information is available on normal variation in placental size and efficiency; however, the timing of the secondary period of loss supports a role for events during placental development and vascularization being critical to survival and potentially contributing to the observed loss.

Key Words: Conceptus survival, Placental function, Reproductive efficiency

ASAS/ADSA Production, Management, and Environment: Management and Production Practices; Beef (Cow-Calf and Feedlot) and Sheep

956 Factors affecting profitability of the cow-calf enterprise. B.H. Dunn*, R.J. Pruitt, and E.D. Hamilton, *South Dakota State University.*

The cow-calf enterprise (CCE) was analyzed for factors affecting profitability with production and financial data from 148 individual CCE enterprises from the states of SD, MT, NE, IA, MN, WY, ND, and KS from 1991-1999. Data were collected at the herd level according to Standardized Performance Analysis (SPA) guidelines. SPA financial measurements are reported on a per 100 kg weaned calf (CALF), per beginning year breeding female (FEMALE), and a per hectare used by the CCE (HA). Profit is defined as return on assets (ROA). Mean separation was used to describe the relationships between levels of profit and SPA measurements. Enterprises were divided into three profit groups based on ROA. High Profit (HP) is defined as those CCE with a ROA > 1 SD above the mean ROA. Low Profit (LP) are those CCE with a ROA < 1 SD below the mean. Medium Profit (MP) are CCE with ROA of -6.7 to 12.9%. Of the 23 SPA production measurements used to describe the CCE by size, reproductive performance, and the production of weaned weight, the only variable for which HP enterprises were higher ($P < 0.10$) than MP and LP enterprises was weaning percentage. The weaning percentages were 90.2, 86.6 and 83.4 for HP, MP, and LP. The same was not the case for the comparisons of SPA financial measurements. On a CALF basis, HP had fewer total dollars invested than did MP ($P < 0.05$), lower depreciation expenses ($P < 0.10$), and lower total expenditures ($P < 0.05$) than both MP and LP enterprises. By all three units of measure, HP had lower breakevens ($P < 0.05$), and higher net income and ROA ($P < 0.01$) than MP and LP. Factors affecting ROA were determined with multiple regression. A predictive equation with an R^2 of 0.813 included the independent variables net income, owners equity, pregnancy percentage, and the interaction of net income and owners equity ($P < 0.05$). These analyzes of the CCE indicate that high ROA is not a function of size, but low levels of investment, average levels of weaned weight, high reproduction, high net income, and low total expenditures.

Key Words: Cow-calf, Profit, SPA

957 Characterization of the production and financial performance of the cow-calf enterprise using Standardized Performance Analysis. B.H. Dunn*, E.D. Hamilton, and R.J. Pruitt, *South Dakota State University.*

The cow-calf enterprise (CCE) was described with production data from 185 individual CCEs with 148 providing financial data. Data were compiled over nine years (1991-1999) from CCEs located in the states of SD, MT, NE, IA, MN, WY, ND, and KS. Data were collected at the herd level according to the guidelines of Standardized Performance Analysis

(SPA). The SPA financial measurements are reported on a per 100 kg weaned calf (CALF), per beginning year breeding female (FEMALE), and a per ha used by the CCE (HA). The average CCE consisted of 508 ± 723 beginning year breeding females and $5,067 \pm 9,106$ ha. Hectares per exposed female averaged 9.7 ± 4.7 . The mean beginning Gregorian calving date was 59.4 ± 26.6 . Reproductive performance was measured by mean pregnancy, calving, and weaning percentage which were 93.0 ± 4.6 , 91.4 ± 7.3 and 86.7 ± 7.8 respectively. The percentage of calves born from d 1 - 21, 1 - 42, 1 - 63, and calves born after d 63 were 56.8 ± 5.5 , 84.1 ± 11.6 , 96.0 ± 4.8 , 4.0 ± 4.91 . The average herd replacement rate was $19.7 \pm 19.4\%$. The calves averaged 199.0 ± 28.0 d at weaning. Mean calf weaning weight, kg of weaned calf per cow exposed, and kg of weaned calf per ha utilized by the CCE was 235.9 ± 27.3 kg, 205.0 ± 32.3 , and 44.8 ± 26.7 respectively. The CCEs had an average investment of $\$970.97 \pm 664.91$, $\$2,087 \pm 1473$, $\$473.79 \pm 435.71$ per CALF, FEMALE, and HA respectively. The total annual expenditure was $\$189.55 \pm 98.3$, $\$397 \pm 217$, $\$82.03 \pm 86.52$ per CALF, FEMALE, and HA respectively. Total revenue was $\$206.62 \pm 79.60$, $\$430 \pm 159$, $\$89.27 \pm 71.25$ per CALF, FEMALE, and HA respectively. Net income was $\$17.09 \pm 84.17$, $\$33 \pm 175$, and $\$16.92 \pm 41.49$ CALF, FEMALE, and HA respectively. The mean breakeven was $\$154.11 \pm 97.75$, 331 ± 217 , and 69.21 ± 80.20 per CALF, FEMALE, and HA respectively. The mean return on assets was 3.1%. CCEs in this sample were large, productive, required a large capital investment, and had low levels of profitability.

Key Words: Cow-calf, Profit, SPA

958 Management factors affecting selling prices of beef calves. T. R. Troxel*, M. S. Gadberry, S. Cline, J. Foley, G. Ford, D. Urell, and R. Wiedower, *University of Arkansas Cooperative Extension Service, Little Rock, AR.*

The objective of this study was to determine how management factors affected selling price of beef calves. Data were collected from January 1 to December 31, 2000 at seventeen Arkansas livestock auctions. The database consisted of 81,703 head of cattle representing 15.3% of the total calves sold. Information was collected by experienced livestock market news reporters and included body condition, time of sale, castration, horn status, fill, health, and individual or group selling. Each factor was analyzed using GLM procedures using month, weight and nearby feeder cattle future prices as covariates and least-squared means were generated. All prices are based upon dollars per 45.45 kg of live weight. Body condition affected selling price ($P < 0.0001$) with very thin, thin, average, fleshy and fat calves selling for $\$85.94$, $\$96.03$, $\$93.63$, $\$91.76$ and $\$88.94$, respectively. The selling price of calves sold during the second third ($\$93.90$) of the sale was higher ($P < 0.02$) than cattle sold during the first ($\$93.64$) and third third ($\93.55). Steers sold for $\$4.63$

more ($P < 0.001$) than bulls and polled calves sold for \$1.49 more ($P < 0.001$) than horned calves. Fill affected selling price ($P < 0.0001$) with gaunt, shrunk, average, full and tanked calves selling for \$97.12, \$95.47, \$93.26, \$88.53, and \$82.16, respectively. Healthy calves sold for \$94.07, which was higher ($P < 0.001$) than dead hair (\$83.37), stale (\$82.49), sick (\$68.27), bad eye(s) (\$81.57) or lame (\$66.67) calves. Calves sold in groups of 2 to 5 head (\$95.14) and groups greater than six (\$94.61) received a higher ($P < 0.04$) selling price than calves sold as individuals (\$93.90). Beef cattle producers can greatly influence the selling prices of their calves through managing calf body condition, castration, horns, fill, health and group selling.

Key Words: Selling price, Beef calves, Auctions

959 Impact of the phenotypic expression of calf genetics on the selling price of beef calves. M. S. Gadberry*, T. R. Troxel, S. Cline, J. Foley, G. Ford, D. Urell, and R. Wiedower, *University of Arkansas Cooperative Extension Service, Little Rock, AR.*

A study was conducted to evaluate the impact of genetic factors on the selling price of beef calves marketed through Arkansas auction barns. Data was collected on 65,743 individually sold calves, marketed through 17 auction barns in y 2000. Data collection was conducted by experienced livestock market news reporters. Information pertaining to the phenotypic expression of calf genetics included subjective identification of breed, color, and USDA frame and muscle scores. Due to the unbalanced nature of the dataset, variables were analyzed individually with month, calf weight, and nearby feeder cattle futures as covariates, and least-square means were generated. All prices are based upon dollars per 45.45 kg of live weight. Breed, color (independent of breed), frame and muscle impacted ($P < 0.01$) feeder calf price. Twenty breed or breed groupings were evaluated. Charolais by Limousin cross calves (\$97.96) brought a higher selling price ($P < 0.001$) than all other breeds whereas Hereford (\$83.37), Brahman (\$80.94), and Longhorn/Longhorn cross calves (\$74.52) were lower in price ($P < 0.001$) compared to other breeds. Yellow-colored calves (\$96.47) brought a higher selling price ($P < 0.001$) compared to all other calf colors. Spotted calves (\$83.84) received the lowest price ($P < 0.001$). Yellow-white face (\$95.65) and black-white face calves (\$95.23) tended to be similar in value ($P = 0.07$), but the price for black-white face calves did not differ from the price of whites (\$94.93; $P = 0.14$). Price due to frame size differed ($P < 0.001$) for all three frame sizes. The selling price for large, medium and small-framed calves was \$94.34, \$93.38, and \$74.81, respectively. Price also differed ($P < 0.001$) for muscle scores 1, 2, and 3 (\$95.02, \$85.35 and \$70.51, respectively). Beef cattle producers can influence the calf-selling price through genetic selection.

Key Words: Feeder calves, Market price, Genetic factors

960 Evaluation of stocking rate and breed type on cattle feedlot production costs and carcass value. J. J. Cleere*¹, A. D. Herring¹, J. W. Holloway², H. Lippke², C. R. Long³, F. M. Rouquette³, and B. G. Warrington², ¹Texas Tech University, Lubbock, ²Texas Agricultural Experiment Station, Uvalde, ³Texas Agricultural Experiment Station, Overton.

Spring born steers ($n = 89$) and heifers ($n = 36$) were assigned to two stocking rates in December 1999 at the Texas Agricultural Experiment Stations in Overton (OVT) and Uvalde (UVL) to create different growth rates. Animals were either 100% Angus (A) or Angus cross (AC) at UVL and were either 75% Angus (A75), 50% Angus (A50) or Brahman (B) at OVT. UVL animals and the OVT B animals were steers, whereas the OVT A75 and A50 were a combination of heifers and steers. Animals grazed TAM 90 (RG) annual ryegrass (*Lolium multiflorum*) in UVL at 2.5 to 4.0 animals/ha (LO) or 4.2 to 6.7 animals/ha (HI). Calves grazed 'Maton' rye (*Secale cereale*) and (RG) in OVT at 3.0 animals/ha (LO) or 6.2 animals/ha (HI). Cattle were placed at the Texas Tech Alltech Research feedlot in May 2000 to determine the influence of stocking rate (SR) and breed type (BT) on feedlot performance and carcass traits. Cattle were randomly assigned to pens by LOC, BT, SR, sex and weight with 4 to 7 animals per pen. Traits on cattle from OVT and UVL were analyzed separately with pen as the experimental unit for all analyses. The statistical model for the UVL cattle included SR, BT and initial feedlot weight as a covariate, whereas the model for the OVT cattle included the same variables plus sex and BT x SR. Among the OVT cattle, SR did not affect carcass value (CARC), feed cost of gain (COG), daily DMI or average daily gain (ADG) ($P > .05$). SR did not affect CARC,

COG or ADG among the UVL animals ($P > .05$). However, the HI animals had a higher daily DMI ($9.57 \pm .12$ kg) than the LO animals ($9.16 \pm .18$ kg) ($P < .10$). BT did not affect CARC, COG or ADG among the OVT animals ($P > .05$). However, the B cattle consumed less feed ($7.49 \pm .39$ kg/d) in comparison to the A50 ($10.28 \pm .20$ kg/d) and the A75 ($11.14 \pm .38$ kg/d) ($P < .05$). There was also a potential BT x SR interaction among the OVT animals for daily DMI ($P = .11$). Among the UVL animals, BT did not affect CARC, COG, or ADG ($P > .05$). The A animals had a higher DMI ($9.81 \pm .10$ kg) than the AC animals ($8.92 \pm .21$ kg) ($P < .05$). Previous management should be considered in marketing feedlot cattle.

Key Words: Beef cattle, Feedlot costs, Carcass value

961 Phenotypic relationships between serial ultrasound measures of body composition in commercial beef feedlot animals determined with a random regression model. T.L. Fernandes*¹, S.P. Miller¹, and C.J.B. Devitt², ¹University of Guelph, Guelph, Ontario, Canada, ²Beef Improvement Ontario, Guelph, Ontario, Canada.

Objective was to determine the relationship between serial ultrasound measurements within an animal (rib-eye area-REA, backfat-BF, and intra-muscular fat-IMF) in relation to body weights and days on feed. Serial ultrasound measurements were obtained from 165 feedlot cattle in Ontario over 7 months (from entry into the feedlot until slaughter). Number of scans per animal ranged from 3 to 6. For each animal, univariate, random linear regressions of REA, BF and IMF on body weight (261-708 kg) or days on feed (30-205 days) were fit. (Co)variance components for intercept, slope and residual were estimated by Restricted Maximum Likelihood (REML), implementing an average information algorithm in the Statistical package ASreml. The estimated covariance function was expanded to determine the (co)variance between any weight or days within the recorded range. For regression on weight, correlations of ultrasound measures within animal ranged from 0.26-0.55, 0.29-0.94, and 0.24-0.75 for REA, BF, and IMF respectively, between measures at 50kg intervals and measure at 600 kg. For regression on days on feed, correlations between measures within an animal ranged from 0.42-0.55, 0.69-0.92, and 0.46-0.66 for measures at 30-day intervals, with 120 days on feed for REA, BF, and IMF, respectively. (Co)variances estimated form a basis for further studies investigating predictions of carcass merit with early ultrasound measures.

Key Words: Cattle, Ultrasound, Predictions

962 Effect of different implant regimes on the accuracy of ultrasound for prediction of body composition characteristics in beef cattle. T.L. Perkins and B.L. Frieden*, *Southwest Missouri State University.*

The objective of this study was to examine the effect of different implant regimes on the accuracy of ultrasound for the estimation of body composition characteristics in beef cattle. Ultrasonic measurements of longissimus muscle area (LMAU), 12th-rib fat thickness (FTU), and percent intramuscular fat (PFATU) were taken by one technician. Cattle were harvested at 110 d ($n=21$), 141 d ($n=3$), 160 d ($n=25$), 180 d ($n=23$), 201 d ($n=25$), 208 d ($n=20$) and 258 d ($n=24$) after being scanned. Carcass measurements included: hot carcass weight (HCW), longissimus muscle area (LMAC), fat thickness at the 12th rib (FTC), preliminary yield grade (PYG), kidney, pelvic, and heart fat (KPH), marbling score (MS), final yield grade (YG), and final quality grade (QG). All crossbred steers ($n=141$) were scanned ultrasonically and implanted on the same day. One of four implant regimes were administered in a completely randomized design as follows: control ($n=36$) with no implant (TRT1); Ralgron® ($n=31$) (zeranol, 36 mg; Schering-Plough, Union, NJ) (TRT2); Revalor® ($n=35$) (24 mg estradiol, 120 mg trenbolone acetate; Hoechst Roussel Vet., Warren, NJ) (TRT3); and double Revalor® ($n=39$) (TRT4) implant. Means by treatment for FTC, REAC, MS, FTU, LMAU, PFATU, and HCW were 1.05 cm, 94.29 cm², 5.3, .65 cm, 65 cm², 3.6% (TRT1); 1.09 cm, 93.69 cm², 5.2, .57 cm, 64 cm², 3.4% (TRT2); 1.02 cm, 94.63 cm², 5.1, .49 cm, 63 cm², 3.3% (TRT3); .84 cm, 96.83 cm², 5.0, .53 cm, 63.2 cm², 3.3% (TRT4) respectively. Correlations between FTU and FTC by treatment were .71; .73; .60; and .61 for each implant regime. Correlations between LMAU and LMAC by treatment were .40; .57; .43 and .58 for each implant regime. Correlations between PFATU and MS by treatment were .27; -.08; .47;

and .37 for each implant regime. These data suggest that ultrasound accuracy was affected by different implant regimes. Implant treatment affected accuracy of fat prediction less than it did accuracy of muscle area or marbling.

Key Words: Ultrasound, Implant, Accuracy

963 Effects of anabolic implants on intramuscular lipid deposition. K. R. Smith^{*1}, J. R. Sackmann¹, S. K. Duckett¹, and T. D. Pringle¹, ¹University of Georgia, Athens, GA.

Ten Angus heifers (386 kg) sired by high marbling EPD bulls were used in a 108 d finishing trial to determine effects of anabolic implants on i.m. lipid deposition. Five randomly selected heifers were implanted with Synovex-Plus (SP; 28 mg estradiol benzoate containing 200 mg of trenbolone acetate) at d 0 and 55. The remaining five heifers were not implanted and served as controls (N). Real-time ultrasound measurements of ribeye area (UREA), fat thickness (UFT) and intramuscular lipid (UIMF) percentage were recorded at 28 d intervals throughout the finishing period. At 108 d, all heifers were harvested and carcass data recorded. One steak (2.54 cm thick) was removed from the 12/13th rib, trimmed of all subcutaneous fat and connective tissue, and pulverized in liquid nitrogen to obtain total lipid content. Ultrasound and performance data were analyzed using the GLM procedure of SAS with time, treatment and two-way interaction in the model. Carcass and lipid data were analyzed using GLM with treatment in the model. Average daily gain was 36% greater ($P < 0.01$) for SP than N. UREA increased ($P < 0.05$) over time for both treatments; however, SP increased at a faster rate than N (0.31 vs 0.23 cm²/d). UFT and UIMF increased ($P < 0.001$) across time-on-feed but were similar between treatments. Implantation altered ($P < 0.06$) the magnitude of change in UIMF over time during finishing, with 82% of the total UIMF deposited between d 27 to 55 in SP and 48% of the total UIMF deposited between d 55 to 80 in N. Final live weight and hot carcass weight were 11% greater ($P < 0.07$) for SP than N. Ribeye area was larger ($P < 0.01$) by 23% for SP than N. SP had 10% greater ($P < 0.05$) overall maturity scores than N. Other carcass measures including marbling score and quality grade were similar ($P > 0.05$) between treatments. Total lipid content of the longissimus was similar ($P > 0.05$) between SP and N. Use of anabolic implants in heifers with the genetic potential to marble did not alter ultimate i.m. lipid content of longissimus; however, pattern of i.m. lipid deposition was altered by implantation.

Key Words: Beef, Implant, Lipid

964 Effects of Implants on Growth Performance of Steers Wintered on Dormant Native Tallgrass Prairie, Subsequent Performance, and Carcass Merit. G.W. Horn^{*}, C.J. Ackerman, S.I. Paisley, and B.A. Gardner, Oklahoma Agricultural Experiment Station, Stillwater, OK/USA.

Three hundred, twenty fall-weaned crossbred steer calves (214 ± 21.9 kg) received either no implant (Control), or were implanted with Synovex-C[®] (SC = 10 mg estradiol benzoate + 100 mg progesterone), Synovex-S[®] (SS = 20 mg estradiol benzoate + 200 mg progesterone), or Revalor-G[®] (RG = 8 mg estradiol-17β + 40 mg trenbolone acetate) to determine the effects of implants on weight gain during winter grazing on dormant tallgrass prairie, subsequent grazing and finishing performance, and carcass merit. Steers grazed two dormant tallgrass prairie pastures from October 23, 1998 until April 5, 1999 (164 d) and received 1.82 kg/d of a cottonseed meal and wheat middling-based 20% CP supplement. Following winter grazing, all steers were implanted with Ralgro[®] (36 mg zeranol) and grazed a common tallgrass prairie pasture until July 15 (101 d). After summer grazing, all steers were implanted with Revalor-S[®] (24 mg estradiol-17β + 120 mg trenbolone acetate) and winter implant treatment groups were equally allotted to two pens in a commercial feedlot. Steers were harvested November 19, 1999 after a 127 d finishing period. Data were analyzed by least squares analysis, and treatment sums of squares were separated using nonorthogonal contrasts that compared Control vs implanted, RG vs SC (i.e., similar amounts of estrogenic activity), and RG vs SS. Mean daily gains (kg) of all cattle during the winter, summer, and feedlot phases were 0.16 ± .009, 1.05 ± .016, and 1.62 ± .029, respectively, and were not influenced by implanting. Steers implanted during the wintering phase had increased ($P < 0.05$) skeletal maturities. "B" maturity carcasses were increased 5.1, 8.8, and 2.4 percentage units by SC, SS, and RG implants. This is consistent with

our previously reported results, and brings to question the efficacy of continuous use of growth-promoting implants in coordinated beef cattle production systems and effects on carcass value.

Key Words: Growing Steers, Implants, Carcass Merit

965 Effect of Feed Intake Restriction on Animal Performance and Carcass Characteristics. C.D. Drager^{*}, M.S. Brown, M. Jeter, P. Dew, and E. Cochran, West Texas A&M University.

An experiment was conducted to study the effect of the severity of DMI restriction on performance and carcass characteristics of feedlot cattle. Crossbred steers (n = 256, 311 ± 1.6 kg initial BW) were block by BW, randomly assigned to one of four treatments (28 pens, 7 pens/treatment), and fed a common 90% concentrate diet. Treatments were: 1) 75% of DMI of steers allowed ad libitum access (AL) for 65 d, 95% of AL for 65 d, and AL for 21d (AL85); 2) 80% of AL for 65 d, 100% of AL for 65 d, and AL for 21 d (AL90); 3) 85% of AL for 65 d, 105% of AL for 65 d, and AL for 21d (AL95), and 4) AL for 151 d (AL100). Feed was offered at approximately 110% of appetite for steers allowed ad libitum access. Feed refused was weighed, and ingredient and diet DM were determined weekly. Feed was offered for AL85, AL90, AL95 based on DMI by AL100 the previous week. All steers were fed a similar quantity of DM for 3 d prior to initial, interim, and final BW determination. Overall DMI was increased ($P < 0.01$) for AL100 compared to the average of restricted steers and increased linearly ($P < 0.01$) with increasing DMI of restricted steers (8.92, 9.13, 9.36, 9.74 ± 0.08 kg/d for AL85, AL90, AL95, and AL100, respectively). Overall ADG (carcass-adjusted) was decreased ($P < 0.01$) for restricted steers compared to AL100 (1.46, 1.60, 1.57, 1.67 ± 0.03 kg/d). Overall ADG and ADG:DMI (carcass-adjusted) responded quadratically ($P < 0.04$) with increasing DMI of restricted steers. Hot carcass weight, ribeye area, and kidney, pelvic, and heart fat percentage were increased ($P < 0.03$) for AL100 compared to restricted steers, and responded quadratically ($P < 0.07$) with increasing DMI of restricted steers. The number of carcasses grading Choice, Select, ≥ low Choice, or Select + Standard did not differ ($P > 0.14$). The severity of restriction and pattern of increasing feed intake resulted in 17, 12.7, and 8 kg/steer less total DM consumed, decreased average daily gain, and decreased gross carcass value an average of \$25 for restricted steers.

Key Words: Feed Restriction, Caloric Restriction, Feedlot Cattle

966 Feedlot performance and carcass characteristics of Mashona-sired steers. G. C. Duff^{*}, D. A. Walker, K. J. Malcolm-Callis, J. E. Sawyer, J. Weaver, and M. G. Thomas, Clayton Livestock Research Center, New Mexico State University, Clayton.

Seventy-one Mashona (Sanga-type cattle indigenous to Zimbabwe)-sired Brangus or Angus crossed steers (191 kg initial BW) were used to evaluate CP concentration (phase 1; 84 d) and protein source (phase 2; 126 d) on finishing performance and carcass characteristics. During phase 1, treatments were no added CP (3 pens; 12 steers/pen) or a diet containing 14% CP (DM basis; 3 pens; 11 or 12 steers/pen). Steers fed 14% CP diets had greater ($P < 0.01$) ADG, daily DMI, and gain:feed (G:F) than steers fed diets with no added CP during the first 84-d. After 84-d, steers fed diets with no added CP during phase 1 were allotted to 14% CP treatment diets (two pens/treatment; nine steers/pen) containing either soybean meal (SBM) or urea as CP sources; steers fed 14% CP in phase 1 served as controls (diets contained 4.5% SBM and 1% urea). During the final 126 d finishing phase ADG was greater ($P < 0.01$), daily DMI was decreased ($P < 0.05$) and G:F was increased ($P < 0.01$) for the average of SBM and urea diets vs controls. Likewise, final BW was increased ($P < 0.01$) for controls vs the average of SBM and urea diets (490, 462, and 468 kg for controls, SBM, and urea diets). No differences ($P > 0.10$) in performance were detected between SBM or urea as CP sources. Hot carcass wt (303.6, 282.4, and 284.6 kg) and longissimus muscle area (76.7, 72.2, and 72.9 cm² for control, SBM, and urea diets, respectively) were increased ($P < 0.05$) for controls relative to the average of SBM and urea diets. Dressing percent (62.0, 61.3, 61.0), marbling score (53.7, 48.7, 51.7), fat thickness (1.36, 1.11, 1.12 cm), internal fat (2.1, 2.1, 2.0) and percentage carcasses grading choice + prime (88.6, 88.2, 94.4% for controls, SBM, and urea, respectively) did not differ ($P > 0.10$) between treatments. Results suggest that Mashona-sired steers perform best with 14% CP concentrations typical of commercial feedlot

diets. Likewise, either SBM or urea can be fed to Mashona-sired steers after feeding low CP diets.

Key Words: Mashona, Performance, Carcass Characteristics

967 Effect of two weaning systems on milk composition, storage, and ejection in dairy ewes. B. C. McKusick*¹, Y. M. Berger¹, P. G. Marnet², and D. L. Thomas¹, ¹University of Wisconsin-Madison, Madison, WI, ²Institut National de la Recherche Agronomique, Rennes, France.

In small dairy ruminants, a mixed weaning system (MIX) of suckling and machine milking is commonly used during the first 30 d of lactation. The main disadvantage of the MIX system is the markedly low fat content in the machine milk. We hypothesize that the inhibition of milk ejection during machine milking along with alteration in storage of milk fat between milkings is responsible. Twenty-six East Friesian crossbred dairy ewes were used to study the effects of two weaning systems on milk composition, storage, and ejection during the first 4 wk of lactation. At parturition, ewes were randomly assigned to two weaning system groups: no suckling and exclusive twice daily machine milking (DY1, n = 10), or the MIX system of once daily machine milking in the morning and then suckling for 10 hr per day (n = 16). Ewes were injected with saline (control), oxytocin (OT), or an oxytocin-receptor blocking agent (AT) prior to a morning milking once weekly, and machine milk was sampled to evaluate milk storage within the udder. Milk and milk protein yields ($1.15 \pm .10$ kg and 58.4 ± 4.7 g, respectively) were similar for DY1/AT, MIX/control, and MIX/AT ewes, and less ($P < .05$) than DY1/controls ($1.49 \pm .10$ kg and 77.4 ± 5.1 g, respectively). This observation confirms inhibition of the milk ejection reflex during machine milking of MIX/control ewes, as only 75% of total machine milk and milk protein is recuperated (cisternal milk). MIX/control and MIX/AT ewes yielded less ($P < .001$) milk fat (28.8 ± 4.3 g) compared to DY1/AT ewes (57.2 ± 6.1 g). When OT was injected to remove all of the milk within the udder, MIX/OT ewes had similar milk and milk protein yield, but 34% less ($P < .001$) milk fat yield than DY1/OT ewes. These results demonstrate that yield and storage of milk and milk protein within the udder is similar for MIX and DY1 ewes, however, there appears to be proportionally less cisternal storage of milk fat in MIX ewes. The present experiment raises further questions concerning the alveolar transfer, stasis and inhibition of milk fat synthesis in ewes managed within the MIX system.

Key Words: Dairy Ewe, Milk Fat, Milk Ejection

968 Supplementing ewe diets with a microbial enzyme preparation (Fibrozyme). I. Effects on production characteristics during lactation. D. K. Aaron*¹, D. G. Ely¹, W. P. Deweese¹, E. Fink¹, B. T. Burden¹, and K. A. Dawson², ¹University of Kentucky, Lexington, KY, ²Alltech Biotechnology Center, Nicholasville, KY.

Twenty-four Polypay ewes (70 kg), with twin lambs, were used to determine effects of dietary supplementation with a microbial enzyme preparation (Fibrozyme, Alltech Biotechnology Center, Nicholasville, KY) on production characteristics. Each ewe and her lambs were placed in individual pens, at 8 d postpartum, and randomly assigned to one of two treatments: F (2 g Fibrozyme, topdressed, 2x/d, n = 12) or C (no Fibrozyme, n = 12). The daily basal diet consisted of 1.0 kg grain,

0.9 kg alfalfa cubes, and corn silage fed to appetite. Ewes, separated from lambs, had access to diets from 0800 to 0930 and 1600 to 1730 daily. Lambs had continual access to a creep diet beginning on d 26. Ewes and lambs were individually weighed and ewes body condition-scored and machine-milked every 7 d from d 15 through 64 of lactation. Weekly feed and creep intakes were recorded. By d 29, estimated 24-h milk production was higher for F than for C ewes (3.17 vs 2.80 kg; $P < .05$), and F ewes continued to produce more milk ($P < 0.05$) on each of the remaining collection days (d 36: 3.08 vs 2.66 ; d 43: 3.00 vs 2.58 ; d 50: 3.00 vs 2.48 ; d 57: 2.70 vs 2.23 ; d 64: 2.33 vs 1.70 kg). Overall, F ewes produced 18 kg more milk (144 vs 126 ; $P < .01$), consumed slightly more feed (275 vs 269 kg), and produced milk more efficiently (0.52 vs 0.47 ; $P < 0.10$). Ewes in both groups tended to gain weight and condition, but no significant differences were found between treatments. Lamb pairs nursing F ewes consumed less creep feed from d 26 through 64 than those nursing C ewes (37.6 vs 45.6 kg; $P < .05$), but twin lamb weaning weights were similar (52.8 vs 53.4 kg) and lamb production efficiencies were equal (0.12). These results indicate Fibrozyme can have a positive effect on milk production, but its effects on lamb growth may be offset by lower creep feed intake.

Key Words: Ewes, Lactation, Enzyme Supplement

969 Supplementing ewe diets with a microbial enzyme preparation (Fibrozyme). II. Effects on nutrient utilization during lactation. D. G. Ely*¹, D. K. Aaron¹, W. P. Deweese¹, E. Fink¹, B. T. Burden¹, and K. A. Dawson², ¹University of Kentucky, Lexington, KY, ²Alltech Biotechnology Center, Nicholasville, KY.

Twenty-four Polypay ewes (70 kg), with twin lambs, were used to determine effects of dietary supplementation with a microbial enzyme preparation (Fibrozyme, Alltech Biotechnology Center, Nicholasville, KY) on total GI tract nutrient digestibility and ruminal metabolism. Each ewe and her lambs were placed in individual pens, at 8 d postpartum, and randomly assigned to treatment: F (2 g Fibrozyme, topdressed, 2x/d, n = 12) or C (no Fibrozyme, n = 12). The daily basal diet contained 1.0 kg grain mix, 0.9 kg alfalfa cubes, and corn silage fed to appetite (3.9 kg av.) from d 8 through 64 postpartum. Ewes, separated from lambs, had access to diets from 0800 to 0930 and 1600 to 1730 daily. Fecal grab samples were taken at 12-h intervals, advanced 2 h daily, from d 33 to 39. Samples were dried, composited by ewe, and analyzed for DM, N, ADF, and NDF. Acid-insoluble ash was used as an internal indicator. After the last fecal sampling at 0800 on d 39, ruminal fluid was obtained from each ewe with a stomach tube (0 h). Ewes were fed immediately after this sampling. Ruminal fluid was also collected 2, 4, 6, and 8 h post-feeding. The pH was determined as samples were collected. Samples were subsequently analyzed for VFA. Digestibilities (%) of DM, CP, ADF, and NDF were 62, 58 ($P < 0.05$); 61, 59 ($P < 0.05$); 32, 27 ($P < 0.05$); and 30, 25 (ns) for F and C, respectively. Ruminal fluid pH was not affected by diet. Total VFA, acetate, butyrate, and valerate concentrations were greater ($P < 0.05$) with F at 8 h post-feeding. Propionate, isobutyrate, and isovalerate were unaffected by diet. Acetate to propionate ratios were greater ($P < 0.05$) for F at 6 and 8 h after feeding. These results indicate Fibrozyme can increase nutrient utilization, by altering ruminal metabolism, in ewes fed high roughage lactation diets.

Key Words: Enzyme, Digestibility, Ruminal VFA

ASAS/ADSA Ruminant Nutrition: Growing Cattle

970 Influence of mass of ruminal contents on voluntary intake of steers fed concentrate and forage diets. Marcela A. Schettini*, Edward C. Prigge, and Eric L. Nestor, West Virginia University.

Five ruminally cannulated steers (590 kg) were fed a high concentrate (C) or a hay (H) diet in a 5×5 Latin square experiment to evaluate the influence of mass of rumen contents on voluntary intake and rumen function. Mass of ruminal contents was altered by adding varying weights of modified tennis balls (6.7-cm diameter) to the rumen before the initiation of each experimental period. Treatments consisted of 0 balls added to the rumen and fed 70 % C (control), 75 balls with a specific gravity (SG) of 1.1 fed C, 75 balls with SG 1.4 fed C, 75 balls with SG 1.1 fed H, and 75 balls with SG 1.4 fed H. Total weight of the balls

was 12.75 and 16.35 kg for 1.1 and 1.4 SG, respectively. Daily DMI was 15.11, 11.93, 10.65, 6.09, and 5.10 for control, 1.1 SG balls fed C diet, 1.4 SG balls fed C diet, 1.1 SG balls fed H diet, and 1.4 SG balls fed H diet, respectively. Addition of balls into the rumen of steers fed the C diet decreased DMI ($P < 0.01$), and increasing SG of balls in the C and H diet decreased DMI ($P < 0.05$) further. Digestibility of NDF, ADF, and CP, and DM were not influenced by the addition of balls nor by increasing SG of the balls for steers fed C and H diet. Adding balls to the rumen of steers fed the C diet decreased particle passage rate (PR) ($P < .05$), while increasing SG of balls decreased particle PR for C and H diet. Liquid dilution rate (LDR) was decreased by the addition of balls in the rumen of the steers ($P < 0.05$) fed the C diet and increasing SG of the balls decreased LDR ($P < 0.01$) for both H and C diets.

Addition of balls in the rumen of steers fed the C diet decreased ($P < 0.01$) the proportion of medium (1.1-1.4) and increased ($P < 0.01$) the proportion of low (<1.1) functional SG digesta particles. Balls added to the rumen of steers fed C diet increased ($P < 0.05$) digesta particle size. Ruminant NH₄ levels of steers fed the C diet were decreased ($P < .01$) with addition of balls. These results suggest that physical factors in the rumen have an influence on voluntary intake of both forage and concentrate diets.

Key Words: Beef Cattle, Voluntary Intake, Concentrate

971 Intake characteristics of beef steers consuming hay ad libitum. E.E.D. Felton* and M.S. Kerley, *University of Missouri, Columbia Missouri.*

Chopped alfalfa and big bluestem (early(EC) & late cut(LC)) hay were used in two 4X4 Latin square experiments (Exp.1 & Exp.2) to investigate the decrease in forage intake associated with decreasing forage quality. Treatments consisted of 100%EC or LC and 67%EC 33%LC or 33%EC 67%LC fed at 110% of ad-libitum intake. Dual-cannulated beef steers (Exp.1 & Exp.2 average BW = 298 & 321 kg, respectively) were used in both experiments. Diet and refusal samples were separated by particle size (fractions: (A) particles > 19mm, (B) between 19 and 8mm, & (C) < 8mm) using the Penn State particle separator and analyzed for fiber and CP. In both experiments, quality of the diets decreased (increased ADF & NDF, decreased CP) linearly ($P < .01$) which resulted in a linear reduction in intake in Exp.1 ($P = .08$) and in Exp.2 ($P < .01$). In neither experiment were the proportions of particles within each diet or refusals affected by treatment (Diet-Exp.1 fraction A=8.24%, B=20.18%, C=71.58% & Exp.2 fraction A=21.56%, B=20.74%, C=57.70% and Refusal-Exp.1 fraction A=37.62%, B=33.64%, C=28.74% & Exp.2 fraction A=28.49%, B=24.89%, C=46.62%). From particle analysis of feed and refusals, animals in both experiments consumed a greater percentage of fraction C than of B or A. Fraction C of feed and refusals for both experiments had a higher ($P < .05$) concentration of protein and less ($P < .05$) fiber than fraction B or A. Correlation analysis of DMI to forage NDF, ADF and CP, were different between Exp.1 and Exp.2. Dry matter intake in Exp.1 appeared only marginally correlated with NDF (-.43, $P = .09$) and CP (.41, $P = .10$) and was not correlated with ADF. In Exp.2, DMI was highly correlated with ADF (-.90, $P < .01$) and CP (.84, $P < .01$) and had a moderate correlation with NDF (-.65, $P < .01$). These results indicated that NDF from lower fiber forages does not have the same effect on DMI intake as does the NDF from higher fiber forages and may not be a good indicator of bulk fill.

Key Words: Intake, Forage, Steers

972 Effect of rate of liveweight gain during winter grazing on blood constituents during adaptation of cattle in the feedlot. M. J. Hersom, R. P. Wettemann, G. W. Horn, and C. R. Krehbiel, *Oklahoma Agricultural Experiment Station, Stillwater, OK.*

Forty-eight fall-weaned Angus x Hereford steer calves (244 ± 23 kg) were used in a completely random design to determine the effect of rate of liveweight gain during winter grazing and subsequent feedlot gain on serum and plasma hormones and metabolites. During the 120-d grazing period, the three treatments were: high (HGW, 1.28 kg/d) and low (LGW, 0.48 kg/d) gain on wheat pasture, and winter grazing of dormant tallgrass native range (NR, 0.21 kg/d). Prior to the feedlot phase (wk 0), jugular blood (venipuncture) was collected from all steers. Thirty-six steers were placed into three pens/treatment and fed a whole-shelled corn finishing diet. Blood was also collected weekly six times beginning 2 wk after arrival in the feedlot. Concentrations of insulin in serum on wk 0 were influenced by treatment ($P < 0.05$; 2.56 ± 0.42, 1.18 ± 0.40, and .92 ± 0.44 ng/mL for HGW, LGW, and NR respectively) and insulin was greater in HGW steers than LGW or NR steers during wk 4 through wk 7. Concentrations of glucose in plasma were not influenced by treatments after wk 0. Serum triiodothyronine (T₃) concentrations were greater ($P < 0.05$) in HGW than LGW and NR steers on wk 0 (1.6 ± .1, 1.4 ± .1, and 1.2 ± .1 ng/mL) through wk 5. Similarly, thyroxine (T₄) concentrations in HGW steers were greater ($P < 0.05$), than in LGW or NR steers on wk 0 (71.7 ± 3.9, 54.2 ± 3.7, and 49.5 ± 4.0 ng/mL) through wk 5. Concentrations of NEFA in serum were greater ($P < 0.05$) in LGW (500 ± 20 ng/mL) and NR (530 ± 22 ng/mL) steers on wk 0 than HGW steers (286 ± 21 ng/mL). Thereafter, NEFA concentrations were greater ($P < 0.05$) in HGW steers than LGW and NR steers until wk 5. Greater feed intake and/or daily gain before steers

were fed a high-energy diet increased serum concentrations of insulin and increased T₃ and T₄ during the first 5 to 7 wk of the feedlot phase.

Key Words: Growing Cattle, Winter Weight Gains, Hormones

973 Coastal and Tifton 85 hay digestion by steers: I. Cultivar and maturity effects. G. M. Hill*¹, R. N. Gates², J. W. West¹, R. S. Watson¹, and B. G. Mullinix¹, ¹University of Georgia, Tifton, GA/USA, ²USDA-ARS, Tifton, GA/USA.

Bermudagrass hay cultivar [Coastal (C) or Tifton 85 (T85)] and hay maturity (5-wk or 7-wk (7-wk)), effects on growing beef steer intake and digestion were determined. Steers (n=24; 255.2 ± 10.7 kg BW) were ranked by BW and randomly assigned to four hay treatments (TRT) in a 2 X 2 factorial with six steers per TRT. Steers were individually-fed T85 hay from a different source for 10 d, followed by free-choice feeding of TRT hays for 21 d. Fresh water and a free-choice mineral supplement (12.5% Ca, 4% P, 19% NaCl, with trace minerals) were available at all times. Steers received Cr₂O₃ (10 g/steer daily) in gelatin capsules from d 10 to d 20, and 12 fecal samples/steer were collected (d 17 to d 21), dried, composited, and analyzed for Cr, and nutrients. In hay analyses (4 samples/hay) the DM, ash, CP, ADF, and NDF (% DM basis), respectively, were: C-5-wk= 92.0, 7.1, 14.4, 36.8, 75.3; C-7-wk=93.2, 6.7, 10.2, 38.9, 70.3; T85-5-wk=94.2, 6.9, 13.6, 39.0, 78.4; T85-7-wk=94.4, 6.3, 9.9, 40.6, 79.0. Hay cultivar and maturity main effects for DMI (kg/d) and digestibility (%) of OM, CP, ADF, and NDF, respectively, were: Cultivar, C=4.19, 61.6b, 67.1, 59.3b, 61.8b; T85=4.25, 67.7a, 66.0, 69.2a, 71.9a; Maturity, 5-wk=4.25, 65.8, 70.6a, 66.3c, 69.5a, 7-wk=4.18, 63.6, 62.5b, 62.2d, 64.2b; within main effect, for each component (a,b $P < 0.01$; c,d $P < 0.05$). There were no cultivar X maturity interactions ($P > 0.10$) for these variables. Although T85 hays had comparatively high concentrations of ADF and NDF, DMI was not affected ($P > 0.10$), and digestion of OM, ADF and NDF were higher for T85 than C. Maturity of the forage when harvested for hay did not affect DMI, but it decreased CP content and digestion of CP, ADF and NDF.

Key Words: Hay, Steer, Digestion

974 Coastal and Tifton 85 hay digestion by steers: II. Cultivar, maturity and energy effects. G. M. Hill*¹, R. N. Gates², J. W. West¹, R. S. Watson¹, and B. G. Mullinix¹, ¹University of Georgia, Tifton, GA/USA, ²USDA-ARS, Tifton, GA/USA.

Bermudagrass hay cultivar [Coastal (C) or Tifton 85 (T85)], hay maturity [5-wk (5wk) or 7-wk (7wk)], and energy supplementation [None (NE) or added corn (E)] effects on beef steer intake and apparent digestion were determined. Steers (n=36; 261.8 ± 12.9 kg BW) were randomly assigned to treatments (TRT) in a 2 X 2 X 2 factorial arrangement (4 steers/ TRT for hay; 5 steers/TRT for hay and energy). After feeding T85 hay from another source for 10 d, steers were individually-fed TRT diets for 21 d. Gelatin capsules with Cr₂O₃ (10 g/steer daily) were given from d 10 to d 20. Fecal samples (12/steer; d 17 to d 21) were dried, composited, and analyzed for Cr, and nutrients. The DM, ash, CP, ADF, and NDF (% DM basis), respectively, in four samples/hay were: C-5wk= 93.4, 7.7, 14.1, 36.2, 73.0; C-7wk=94.1, 6.4, 9.8, 36.8, 71.4; T85-5wk=94.6, 6.9, 13.3, 38.0, 77.3; T85-7wk=94.6, 6.7, 9.9, 40.0, 78.5. Total DMI was restricted to 90% of hay DMI by similar steers in a companion study. Four TRT were fed hay only, and four TRT were fed rolled corn (89.7% DM, 10.2% CP) at 33% of total DMI. Hay DMI, corn DMI, and total DMI (kg), respectively, were: C-5wk-NE=3.76, 0, 3.76; C-5wk-E=2.51, 1.30, 3.81; C-7wk-NE=3.76, 0, 3.76; C-7wk-E=2.51, 1.29, 3.80; T85-5wk-NE=3.9, 0, 3.90; T85-5wk-E=2.61, 1.33, 3.94; T85-7wk-NE=3.70, 0, 3.70; T-85-7wk-E=2.46, 1.29, 3.76. Cultivar X energy interactions for digestibility (%) of OM and ADF were: OM= C-NE, 46.5, C-E, 56.9, T85-NE, 58.4, T85-E, 59.8 [SE=1.63, F=7.7 ($P < 0.01$)]; ADF= C-NE, 40.9, C-E, 43.7, T85-NE, 60.9, T85-E, 57.0 [SE=1.75, F=3.6 ($P < 0.07$)]. Cultivar, maturity and added energy digestibility (%) for CP and NDF, respectively, were: CP=C, 50.3a, T85, 50.5a; NDF=C 46.4b, T85, 61.1a; CP=5wk, 54.1a, 7wk, 46.7b; NDF=5wk, 57.2a, 7wk, 50.2b; CP=NE, 55.9a, E, 44.9b; NDF=NE, 55.5a, E, 52.0b; within nutrient (a,b, $P < 0.05$). Hay digestibility was greater for T85 than C, and increased hay maturity decreased nutrient digestion. Added energy increased OM digestibility of C hay diets to the level of T85 hay without added energy, but added energy did not increase OM digestion of T85 hays.

Key Words: hay, steer, *Cynodon dactylon*

975 Effect of intake level on the body composition and net energy requirement of Nellore steers and bulls for maintenance and growth. L.O. Tedeschi*¹, D.G. Fox¹, C. Boin², P.R. Leme³, and G.F. Alleoni⁴, ¹Cornell University, Ithaca, NY, USA, ²ESALQ-USP, Piracicaba, SP, Brazil, ³FZEA-USP, Pirassununga, SP, Brazil, ⁴Instituto de Zootecnia, Nova Odessa, SP, Brazil.

Three comparative slaughter experiments with individually fed Nellore bulls (31 animals) and steers (66 animals) were used to determine their NEm and NEg and the effect of level of intake on their composition of gain. Bulls (experiment 1) were divided into two intake levels (60 g DM/kg^{0.75} of shrunk body weight (SBW) and ad libitum of a diet containing 2.3 Mcal ME/kg) and three slaughter groups, which were based on days on treatment (100, 150, and 190 days, and 130, 180, and 200 days, respectively for older and younger animal subgroups). For experiments 2 and 3, steers were allocated to three intake levels (55 and 70 g DM/kg^{0.75} SBW, and ad libitum of a diet containing 2.2 Mcal ME/kg). In both trials, three slaughter groups within each intake level were set as when animals of the ad libitum treatment reached 400, 440, and 480 kg SBW on average for the first, second, and third group, respectively. For all experiments, initial body composition was determined with equations developed from a base line slaughter group, using SBW, empty body weight (EBW), fat (EBF), and protein (EBP) as variables. For bulls, there were no differences ($P > 0.05$) between treatments in EBW percentage of protein and water, and fat and protein in the gain (FIG and PIG, respectively). In contrast, in steers level of intake affected EBW percentage of protein and fat ($P < 0.05$), but FIG and PIG were not different ($P > 0.05$). A nonlinear equation with the pooled data was developed to predict retained energy (RE) using maturity degree ($u = \text{actual/mature weight}$, which was estimated to be 350 and 550 kg of SBW at 25% EBF for steers and bulls, respectively); $RE = 0.00949 * EWG^{0.9425} * EBW^{exp(0.0924 * u)}$. The NEm was similar for bulls and steers, and averaged 76 kcal/kg^{0.75} EBW. However, the efficiency of conversion of metabolizable to NEm was greater for steers than bulls (70.6 and 65.2%, respectively), indicating that bulls had an 8.6% greater ME requirement for maintenance than steers ($P < 0.05$). Our analyses do not support the hypothesis that Nellore, a *Bos indicus* species, has a lower net energy requirement for maintenance than *Bos taurus* breeds.

Key Words: body composition, net energy requirement, Nellore

PSA Pathology: Session II

977 Pathogenesis of ascites syndrome in broiler chicken in relation to combined E. coli and infectious bronchitis virus (IBV) infection. M.S. Youssef*, A.H. Bayoumi, A.Z. Mahmoud, S. Mousa, and M. Mubarak, *Veterinary Medicine, Assiut University, Assiut, Egypt.*

Forty white leghorn chicks (one day old and specific pathogen free) were used in this study. Chicks were inoculated via nares with 0.1 ml E. coli (O : 115 serotype O) at the titre of 106.7 colony forming units/ml, and 0.1 ml IBV (Massachusetts serotype M41) at the titre of 105.5 ciliostatic dose 50 (CD 50). The experimental period was 7 weeks. The incidence of ascites was 20%. Tissues from inoculated birds were examined using light and electron microscopes. Immunohistochemistry was also conducted to detect IBV antigen in pulmonary tissue of inoculated birds. Pulmonary lesions were fibrinopurulent pneumonia at early stage followed by late granulomatous reaction. It was concluded that the development of ascites in IBV-E. coli infected birds is attributed to the induced pulmonary lesions which led to a state of pulmonary hypertension.

Key Words: Ascites, broiler chickens, E. coli, IBV

978 Clinicopathological studies on ascites syndrome in broiler chickens with special reference to the role of hypoxia. A.Z. Mahmoud*, A.H. Bayoumi, S. Mousa, M.S. Youssef, and M. Mubarak, *Veterinary Medicine, Assiut Univ., Assiut, Egypt.*

Forty-nine ascitic broiler chickens from 7 different flocks were used in this study. An experimental investigation was also conducted to induce ascites in broiler chickens by creating a hypoxic condition. In the first trial 32 birds were exposed to periodic hypoxia (6 and 12 hrs/day) and in the second trial 24 birds were exposed to periodic hypoxia (6 hrs/day) and fed on pelleted feed. The experimental period was 4 weeks. All

976 Monitoring energy expenditure in sheep from daily heart rate measurement. A Arieli*¹, A Kalouti², Y Aharoni³, and A Brosh³, ¹Hebrew University of Jerusalem, Israel, ²Wageningen Agricultural University, Netherlands, ³Agricultural Research Organization, Ramat Yishay, Israel.

A trial was conducted in sheep to validate the usage of continuous heart rate (HR) monitoring for the prediction of energy expenditure (EE) in free-living animals. Sixteen Assaff lambs (BW 50 kg) were used. Four lambs were slaughtered at the beginning of the experiment, and the others at the end of the experiment. Carcass body composition was analysed and energy retention was calculated. The 12 lambs were kept on metabolic crates for 84 d. Lambs were blocked into 3 dietary treatments: Group HH was fed a 75:25 concentrates: alfalfa hay (C:A) diet during the entire experiment. Group LH were fed 25C:75A diet during the first 42 d, and then switched into a 75C:25A diet. Group LL received 25C:75A diet during the entire experimental period. Feed was given ad libitum. The experimental period was divided into 4 sub-periods of 21 d. During each sub-period, body weight change, daily intake and feces output was measured. Intake of ME was calculated from NRC (1989). HR was recorded by data loggers during 15 to 17 d. On 18 d oxygen consumption (VO₂), using an open circuit mask system, and HR were measured for a period of 15 min, from which oxygen pulse (OP = VO₂:HR ratio) was determined. For each sub-period EE was estimated from daily HR measurements and oxygen consumption, calibrated against OP. Direct measurement of EE could thus be compared with the prediction obtained from the difference between ME intake (MEI) and measured energy retention. Average (and SE) intakes of ME were 857 (33), 854 (39), and 805 (42) kJ/metabolic body weight (MBW)-d in HH, LH, and LL, respectively. The respective energy retentions were 194 (23), 233 (27) and 141 (22) kJ/MBW-d ($P = 0.06$). Overall energy predictability (MEI/(energy retention + EE estimated by the HR method) was 0.957 ($n = 12$; SE 0.024), and was not affected by dietary energy concentration. It is concluded that the HR technique can be used for the estimation of long-term energy expenditure in growing animals.

Key Words: Energy expenditure, Heart rate, Oxygen pulse

exposed birds were investigated for haematological, histopathological, immunohistochemical, and ultrastructural studies. Pathomorphological examination revealed degenerative myocarditis, granulomatous and fibrinopurulent pneumonia, 25% of experimental birds developed ascites, and haematological and pulmonary changes were prominent in them. It was concluded that ascites syndrome in broiler chickens is multifactorial in origin, and heart and lungs are central organs in the pathogenesis of ascites. The development of ascites in hypoxic birds is mediated through haematological and pulmonary changes.

Key Words: Ascites, broiler chicken, Hypoxia

979 Experimental study on sodium intoxication in relation to ascites syndrome in broiler chickens. M. Mubarak*, A.H. Bayoumi, A.Z. Mahmoud, M.S. Youssef, and S. Mousa, *Vet. Med., Assiut Univ., Assiut, Egypt.*

This work was designed to induce ascites in broiler chickens by sodium chloride intoxication. Three experiments were conducted using 40, 40, and 50 chickens, respectively, which received high doses (1.5%) and low doses (0.75%) of sodium chloride (SC), sodium bicarbonate (SB), and sodium phosphate (SP) in their drinking water for 4 weeks. Haematologic parameters, serum level of sodium, creatine kinase and lactate dehydrogenase were estimated. Histopathological and ultrastructural studies were also performed. Ascites was not recorded in high dosed birds. Low dosed birds manifested ascites at the incidence of 40% (SB), 35% (SC), and 10% (SP). Cardiac and pulmonary lesions were observed in ascitic birds. It was concluded that pathogenesis of ascites in sodium intoxicated birds is mediated through pulmonary hypertension induced right sided heart failure.

Key Words: Ascites, broiler chicken, sodium chloride toxicity

980 Detection of experimental *Salmonella enteritidis* and *S. typhimurium* infections in laying hens by fluorescence polarization assay for egg yolk antibodies. R. K. Gast*¹, M. S. Nasir², M. E. Jolley², P. S. Holt¹, and H. D. Stone¹, ¹USDA-ARS Southeast Poultry Research Laboratory, Athens, GA, ²Diachemix Corporation, Grayslake, IL.

The effectiveness of risk reduction programs for controlling egg-borne transmission of *Salmonella* infections to humans depends on accurate detection of infected commercial laying flocks. Although most *S. enteritidis* (SE) control programs in the U.S. have emphasized bacteriological detection of the pathogen in laying house environments and eggs, antibody detection methods have been used successfully elsewhere and are of particular interest in application to egg yolks (which can be collected more conveniently than serum samples). Fluorescence polarization (FP) technology offers advantages over traditional enzyme immunoassays in terms of both speed and methodological simplicity. This study evaluated the sensitivity and specificity of detection of antibodies in the yolks of eggs laid by experimentally infected chickens by FP assays using tracers prepared from the O-polysaccharides of SE and *S. typhimurium* (ST) and an ELISA using an SE flagellin antigen. In 2 trials, groups of specific-pathogen-free laying hens were infected orally with either 10⁶ or 10⁸ cfu of SE (phage type 13a) or with 10⁸ cfu of ST. Egg yolks were obtained at 5 weekly intervals from infected and uninfected negative control hens. Both ELISA and FP (using SE tracers) detected a high percentage of hens infected with SE, although both assays also detected antibodies in eggs from some hens infected with ST. The FP assay for SE was both more sensitive and more specific than the ELISA. Two different SE tracers for FP displayed different sensitivities and specificities of detection. FP using an ST tracer likewise detected ST infection but cross-reacted with antibodies to SE.

Key Words: *Salmonella enteritidis*, Fluorescence polarization, Egg yolk antibodies

981 The role of intracellular sodium in skeletal muscle damage: effects on muscles from two broiler genotypes. D. A. Sandercock* and M. A. Mitchell, *Roslin Institute, Roslin, Midlothian, UK*.

The incidence of idiopathic myopathy is increasing in poultry lines selected for high growth rates and muscle yields. The condition has been linked with impaired muscle intracellular calcium (Ca²⁺_i) homeostasis. Elevations in Ca²⁺_i are known to be associated with the development of myopathy. These increases may be mediated by initial changes in other ions, such as sodium (Na⁺). This study examines the role of Na⁺_i on Ca²⁺_i and muscle damage and compares its effects on these parameters in muscles from two broiler genotypes. The study employed an isolated in vitro chicken skeletal muscle preparation. Alterations in Na⁺_i were induced using the Na⁺ ionophore monensin and Na⁺/K⁺ exchange inhibitor ouabain. In a parallel experiment, muscles from fast (FG) and slow (SG) growing broiler lines were similarly treated. Muscle damage was determined from creatine kinase (CK) loss into the incubation medium. Muscle calcium accumulation was estimated by ⁴⁵Ca²⁺ uptake. Monensin and ouabain treatments both caused similar elevations in ⁴⁵Ca²⁺ uptake (p<0.05) and were associated with increases in CK loss (p<0.001). Effects of simultaneous incubation with both agents were additive. In studies on muscles from FG and SG lines, ⁴⁵Ca²⁺ uptakes and CK losses were not different under control conditions. Treatment with monensin produced differential increases in ⁴⁵Ca²⁺ uptake (p<0.01) and CK loss (p<0.001) in muscles from the two lines. Absolute uptakes of ⁴⁵Ca²⁺ (p<0.05) and CK losses (p<0.001) were greater in muscles from the FG line as were their relative increases (p<0.05). The results suggest initial increases in Na⁺_i can produce elevations in Ca²⁺_i and muscle injury. FG and SG lines exhibit differences in the extent of Na⁺-mediated alterations in muscle Ca²⁺_i and CK loss. It is proposed that subjecting birds to situations which may cause changes in muscle Na⁺_i (e.g. raised muscle activity and stress) should be avoided, especially in current broiler lines, in which sensitivity to Na⁺-induced changes in myopathology appears to be increased.

Key Words: Sodium, Muscle damage, Broiler

982 Idiopathic myopathy in commercial turkeys: a relationship with muscle fiber diameter? M.A. Mitchell*¹, L.J. Mills¹, M. Mahon², and S. Gilpin², ¹Roslin Institute, Roslin, Midlothian, UK, ²Manchester University, Manchester, UK.

Previous studies in this laboratory have described an age dependent, idiopathic or spontaneous myopathy in rapidly growing commercial turkeys associated with an exponential rise in plasma creatine kinase (CK) activity. These effects were not found in an unimproved strain. Growth restriction in commercial turkeys reduced plasma CK, suggesting a link between growth rate, bodyweight and myopathy. The aim of this experiment was to correlate the incidence and extent of this pathology with morphometric characteristics of the muscle fibers. Large, white commercial male-line stags were reared to two weeks of age and split into 2 treatment groups. One group was fed ad libitum (AL) throughout the experiment and the other treatment group was restricted from 5 weeks of age (R), receiving 70% of the reported ad lib food intakes. Every four weeks up to 20 weeks of age 8 birds per treatment were weighed and blood sampled. Plasmas were analyzed for CK activities. Histological analyses were performed upon muscle samples from leg and breast. Bodyweights, fiber diameters and plasma CK activities increased significantly with age in both treatments and were significantly greater in the AL treatment (p<0.001). At 8 weeks body weight and CK activities were significantly higher (p<0.001) in the AL treatment and by 12 weeks fiber diameter was also significantly increased (p<0.001). Regression analysis highlighted almost identical exponential relationships between CK and bodyweight and between CK and fiber diameter for both treatment groups (p<0.001). The take-off point for CK corresponded to approximately 10kg bodyweight and 65mm fiber diameter in both treatments. It is suggested that myopathy is linked to muscles fiber size rather than the rate of growth. Selection in commercial turkeys has achieved greater muscle weights mainly through fiber hypertrophy. The resulting large diameter fibers may exceed a size threshold at which normal function is compromised and pathology occurs. Future selection programs may benefit by concentrating on selection for smaller fiber sizes and greater fiber numbers (hyperplasia) to achieve high muscle yield, good meat quality and muscle health.

Key Words: Turkey, Muscle, Myopathy

983 Bacteriophage prevents *Escherichia coli* respiratory infection in broiler chickens. W. E. Huff*, G. R. Huff, N. C. Rath, J. M. Balog, H. Xie, P. A. Moore, Jr., and A. M. Donoghue, *PPPSRU/ARS/USDA Fayetteville, AR*.

Bacteriophage are viruses that infect and can kill bacteria. A study was conducted to determine if bacteriophage could protect broiler chickens challenged with *E. coli*. There were 13 treatments with 2 replicate pens of 10 chicks. Two treatments consisted of birds challenged at 3 days of age with either 10³ or 10⁴ cfu *E. coli* injected into the thoracic airsac. There were 4 phage treatments that consisted of mixing a bacteriophage isolated from a municipal sewer treatment plant with *E. coli* 24 hours prior to challenging the birds. The 10³ *E. coli* culture was mixed with either 10³ or 10⁶ phage, and the 10⁴ *E. coli* culture was mixed with either 10⁴ or 10⁸ phage. Four treatments consisted of challenging the birds with only 10³, 10⁴, 10⁶, or 10⁸ phage. Three control treatments consisted of unchallenged birds, birds challenged with the culture broth, or birds challenged with phosphate buffered saline. The birds were necropsied at 3 weeks of age. At 1 and 2 weeks of age birds challenged with either 10³ or 10⁴ cfu of *E. coli* had significantly decreased body weights from controls. At 2 weeks of age the birds that received 10⁴ cfu of *E. coli* mixed with 10⁴ bacteriophage had significantly decreased body weights from the controls. Mortality in the birds that received 10³ or 10⁴ cfu of *E. coli* was 80 and 85%, respectively. Mortality of birds that were challenged with either 10³ or 10⁴ cfu of *E. coli* mixed with equal amounts of bacteriophage was 25 and 45%, respectively. Mortality of birds challenged with 10³ or 10⁴ cfu of *E. coli* mixed with 10⁶ or 10⁸ bacteriophage was 5 and 0%, respectively. Based on mortality there was essentially complete protection of the birds given either 10³ or 10⁴ cfu *E. coli* mixed with either 10⁶ or 10⁸ bacteriophage, and partial protection when equal amounts of *E. coli* and bacteriophage were mixed prior to challenge. These data suggest that bacteriophage may have efficacy to prevent *E. coli* respiratory infections in broiler chickens.

Key Words: Bacteriophage, Broiler chickens, *Escherichia coli*

984 Efficacy of bacteriophage to prevent *Escherichia coli* respiratory infection in broiler chickens when administered in the drinking water prior to challenge. W. E. Huff*, G. R. Huff, N. C. Rath, J. M. Balog, H. Xie, P. A. Moore, Jr., and A. M. Donoghue, *PPPSRU/ARS/USDA Fayetteville, AR.*

Bacteriophage are viruses that can infect and kill bacteria. A study was conducted to determine if bacteriophage added to drinking water for 1 wk prior to respiratory challenge of broiler chickens with *E. coli* would provide protection. There were 12 treatments with 2 replicate pens of 10 chicks. The treatments consisted of birds on normal water challenged at 1 wk with either 10^3 or 10^4 cfu *E. coli* injected into the thoracic air sac, or with either 10^3 , 10^6 , or 10^4 , 10^6 phage/ml in their water, respectively. Unchallenged birds were given either 10^3 , 10^4 , or 10^6 phage/ml in their water, and birds on normal water were unchallenged, challenged with the culture broth, or with phosphate buffered saline. The birds were necropsied at 3 wks of age. At 2 wks, birds challenged with 10^4 *E. coli* regardless of water treatment, and birds challenged with 10^3 *E. coli* on normal water had decreased BW, however, birds challenged with 10^3 *E. coli* and given water treated with either 10^3 or 10^6 phage/ml had higher BW than birds challenged with 10^3 *E. coli* on normal water. At 3 wks, unchallenged birds that received 10^3 phage, and birds that received 10^4 phage and challenged with 10^4 *E. coli* had decreased BW. At 1 wk, treatment of water with 10^6 phage/ml decreased mortality by 50% in birds challenged with 10^3 *E. coli*. Total mortality was 55% in the birds that received 10^4 *E. coli* alone, 35% when treated with 10^4 phage, and 40% when treated with 10^6 phage. These data indicate that treating the water of broiler chickens prior to a respiratory challenge with *E. coli* may have provided some protection immediately after challenge.

Key Words: Bacteriophage, Broiler chickens, *Escherichia coli*

985 Effect of feed supplementation with vitamin D metabolites in a dexamethasone-*Escherichia coli* challenge model of turkey osteomyelitis complex. G. R. Huff*, W. E. Huff, N. C. Rath, and J. M. Balog, *PPPSRU/ARS/USDA, Fayetteville AR.*

Supplementation with vitamin D₃ was previously shown to protect *E. coli* challenged birds which were immunosuppressed with dexamethasone (DEX) at 5 wk and at 12 wk of age. The purpose of this study was to determine the effects of continual dietary supplementation with either 10 g/kg 1,25 dihydroxyvitamin D₃ (1,25) or 99 g/kg 25-hydroxyvitamin D₃ (Hy-D) on disease resistance. Seven hundred twenty turkey poults were placed into 24 duplicated floor pens in a 3 X 2 X 2 design comparing each metabolite treatment to controls. At 5 wk of age half of the birds were treated with DEX and half of the DEX-treated birds were challenged with *E. coli*. All mortalities and lame birds were necropsied. At 9 wk all DEX-treated birds were treated with another series of DEX injections. At this time, the birds which had only been challenged with *E. coli* were also treated with DEX. Two weeks later 10 birds/pen were necropsied. After the first series of DEX injections, there was an increase in mortality in the Hy-D supplemented birds which were given both the DEX treatment and the *E. coli* challenge. After the second series of DEX injections the main effect mean body weights were lower in birds given 1,25 as compared to both controls and Hy-D supplemented birds. Mortality was higher in 1,25 supplemented birds which were challenged with *E. coli* at 5 wk and treated with DEX at 9 wk as compared to Hy-D supplemented birds. The 1,25-treated birds which were treated with DEX at both 5 wk and 9 wk and challenged with *E. coli* at 5 wk had higher mortality as compared to both controls and Hy-D birds. The main effect mean mortality was higher in birds given 1,25 as compared to controls and Hy-D birds. The percentage of birds with lesions of turkey osteomyelitis complex (TOC) was decreased from 27% to 0 by both Hy-D and 1,25 in the groups given 2 DEX treatments and *E. coli* challenge. This study suggests that continual supplementation with vitamin D metabolites at these levels can decrease TOC incidence, however this result may be related to a concomitant increase in mortality.

Key Words: vitamin D, turkeys, *Escherichia coli*

Ractopamine at One Year of Commercial Application

986 Biological basis of the ractopamine response. S.E. Mills*, *Purdue University.*

Ractopamine belongs to a class of compounds that binds beta-adrenergic receptors (β AR) and promotes the accretion of muscle protein while reducing body fat. The growth response is observed across many species and with a variety of structurally related compounds, suggesting that a common regulatory pathway is involved. The β AR-selective agonist isoproterenol also stimulates muscle growth in rodents suggesting that β AR, and not other receptors, mediate the hypertrophic response. Three β AR subtypes have been cloned from several mammalian species and specie differences in the relative distribution and pharmacology of subtypes have been demonstrated. These specie differences likely account for the lesser or greater efficacy of specific compounds in specific species. In the pig, the β 1AR is the predominant subtype expressed in the adipocyte (75%) and skeletal muscle (60%), followed by the β 2AR (18 and 39%) and β 3AR (7 and 1%). Ractopamine binds the porcine β 1AR and β 2AR with similar high affinity ($K_d = 25$ to 100 nM). Intracellular signaling through the β AR is achieved via activation of adenylyl cyclase and generation of cAMP. Ractopamine activates adenylyl cyclase but is only 20 to 40% as effective as isoproterenol and may more effectively signal through the β 2AR than the β 1AR. Ractopamine would be considered a partial agonist at both β AR subtypes. In adipose tissue, ractopamine stimulates triglyceride hydrolysis in vivo and in vitro through activation of adenylyl cyclase. Absolute rates of fat accretion are not consistently observed in feeding studies however, likely due to the combination of β AR down regulation with chronic feeding and the partial agonist activity. Ractopamine consistently increases the rate of skeletal muscle protein accretion in pigs, although the response is diminished with time. Down regulation of β AR is less evident in skeletal muscle, which may prolong the positive effect. It is not clear which β AR subtype(s) are linked to protein accretion and what intracellular path-

ways are involved. Answers to these questions may provide insights for the next generation of β AR agonist.

Key Words: pig, adrenergic, receptor

987 Impact of nutrition on the ractopamine response. W. C. Weldon* and T. A. Armstrong, *Elanco Animal Health, Greenfield Indiana.*

Proper nutrition is critical to effective implementation of ractopamine (Paylean[®]) in commercial swine production facilities. There is only a limited response to ractopamine if it is included in diets with limited amino acid fortification. Very simply, the ability of ractopamine to increase lean growth is limited by the availability of nutrients. To make an accurate estimate of the optimal nutrient concentration, it is critical to understand the potential lean growth response to ractopamine. The growth response to ractopamine is dramatic. Several studies have shown that the inclusion of ractopamine in the diet will increase ADG by as much as 275 g/d during the early weeks of ractopamine feeding. The improvements in growth performance decrease over time. Current recommendations are to feed ractopamine so that the majority of the pigs are marketed within four weeks of the initiation of ractopamine feeding. Practically, the primary adjustment necessary in diets containing ractopamine is to increase the amino acid concentration. A summary of four historical data sets indicates that the increased lean growth requires 3.6 to 7.5 g/d more true ileal digestible lysine during 28 d of ractopamine feeding (based on NRC 1998). If the increased lysine needs are distributed based on the relative response in ADG, the lysine requirement is greatest during the first few weeks of ractopamine feeding. The average increase in lysine requirements for the first 21 d of ractopamine feeding (based on historical lean growth data using NRC (1998) calculations) is 6.5 g/d of true ileal digestible lysine. Therefore, if pigs consume 2.5 kg of feed/d, the concentration of true ileal digestible lysine in the diet would need to be increased 0.26%. The results from ongoing studies will further define the interactions between dose and feeding duration

and allow for more specific nutritional recommendations. Feeding ractopamine in diets that are not adequately fortified, may severely limit the improvements in growth performance and carcass composition.

Key Words: Ractopamine, Swine, Nutrition

988 Genetic variation in the response to ractopamine. A.P. Schinckel*¹, B.T. Richert¹, and C.T. Herr¹, ¹*Purdue University.*

Several research trials have evaluated the impact of ractopamine (RAC, Paylean[®], Elanco Animal Health) on barrows and gilts of various genetic populations (GP). Overall, the desirable response of RAC to increase daily carcass lean gain, improve feed efficiency, and increase carcass lean percentage has been observed in GP of substantially different lean growth rates and carcass lean percentages. Three trials have evaluated the magnitude of GP × RAC interactions. Carcass muscle accretion (g/d) increased with RAC to a greater extent in high lean gain (HL) barrows than low lean gain (LL) barrows ($P < .02$, Bark et al., 1992, *J. Anim. Sci.* 70:3391). Dissected fat accretion (g/d) was reduced by a greater magnitude in the HL than the LL barrows ($P < .04$). Gu et al. (1991, *J. Anim. Sci.* 69:2694) evaluated the RAC response in five GP of barrows and found significant RAC by GP interactions ($P < .05$) for daily carcass lean gain. Regression of GP means for carcass lean gain with RAC on the carcass lean gain of the control for the five GP indicated that the RAC response was best described as a constant percentage (25%) increase in daily lean gain above the controls. The third trial (Herr et al., 2001) evaluated the response of Paylean in 300 gilts in a 3 × 4 factorial with three GP (commercial terminal crosses) and four RAC levels (0, 5, 10, and 20 ppm). The GP had similar carcass lean percentage. No GP by RAC interactions were found ($P > .10$). Overall, the research indicates that RAC has a positive impact on barrows and gilts with substantially different genetic potentials for lean growth and carcass lean percentage. The RAC response to increase lean growth has been found to be proportional to the genetic potential of the GP. Recent research has found significant GP by environmental interactions for pigs reared in different health status environments. Environment by RAC and environment by RAC by GP interactions for compositional growth in pigs need to be evaluated.

Key Words: Ractopamine, Swine genetics, Lean Growth

989 Effects of ractopamine on meat quality. F. K. McKeith* and M. Ellis, *University of Illinois, Champaign-Urbana, IL.*

Ractopamine has been approved for use in pigs in the United States. Previous work on this compound has carefully characterized its effects on carcass growth and composition and some classical evaluations of fresh meat quality (color, firmness, and marbling) and palatability. The majority of the information available is a decade or more old. Results from these studies suggested that ractopamine had no effect on visual color, firmness, or marbling. Instrumental color was evaluated in one study and no effect was observed in L* value (lightness) but a* value

(redness) was reduced. Water holding capacity (drip loss) and ultimate pH were not affected by ractopamine; however, ham curing yields were improved in two studies. The impact of ractopamine was inconsistent for Warner-Bratzler shear force (some studies reported an increase and other studies observed no difference). Sensory tenderness, juiciness, and flavor were not affected. Since its approval, several studies have been conducted using contemporary genotypes to help characterize the fresh meat quality attributes. Preliminary results from these studies are consistent with previous research. Detailed fresh meat quality evaluations suggest that visual color, firmness, and marbling were not affected. Instrumental L* was not affected; however, a* was reduced. Ultimate pH was significantly higher in ractopamine fed animals, but, drip loss and purge loss were not affected. Results from current studies and previous work suggest that ractopamine does not affect pork quality.

Key Words: Pork, Quality, Ractopamine

990 Potential impact of ractopamine on environmental stewardship. A.L. Sutton*, B.T. Richert, S.L. Hankins, S.A. DeCamp, and A.L. Carroll, *Purdue University.*

Numerous studies have shown that ractopamine hydrochloride (RAC) used in finisher swine diets increases the amount of lean tissue in pork carcasses and improves production efficiency (G:F and ADG). With increased body N retention, less feed consumed per unit of lean tissue gain and 4 to 6 d less to market weight, the use of RAC may lead to environmental benefits by reducing manure volume and N excretion. Theoretically, if the same total amount of US lean pork is maintained but with 12.7% improvement in G:F and 9.8% increased ADG due to feeding RAC, then fewer pigs would be required to generate this amount of lean. Consequently, significantly less feed resources (land required for crop production), fertilizer, chemicals, water usage and energy would be required. Little research has directly measured manure volume, nutrient excretion and odors from feeding RAC in commercial diets. A metabolism trial with 84-kg pigs and a 64-d manure incubation study were conducted to determine the effect of RAC on N excretion and odors in stored manure. A 13.8% CP, 0.80% Lys diet representing the industry standard diet for high lean gain pigs was compared to a current approved diet with 16.1% CP, 1.10% Lys + 20 ppm RAC. RAC decreased urine volume (12.6%) and tended to decrease total manure output (7.9%). Pigs fed the RAC diet excreted 14.9% less total N compared to the 13.8% CP standard non-RAC diet due to reduced urinary N excretion. In a 30-d feeding period and 4 less days to market, N excretion would be reduced 206 g per pig marketed. Slurry pH was reduced 0.5 units and ammonia was reduced 8-21% from pigs fed RAC. In an attempt to maximize N utilization and minimize N excretion, a 13.8% CP, 1.10% Lys + 20 ppm RAC diet was fed. The 13.8% CP + RAC diet reduced N excretion by 35.7% and decreased slurry ammonia and VFA production in stored manure to help reduce odors. The utilization of RAC in swine diets could result in additional environmental benefits and improved environmental stewardship.

Key Words: Pigs, Ractopamine, Nitrogen excretion

Teaching Techniques for Meat Judging Coaches

991 Preparing animal science graduates to think critically, compare logically, decide independently, solve problems rationally, communicate effectively and lead decisively. Gary C. Smith*, *Colorado State University.*

If the animal science curriculum is appropriately crafted and structured, undergraduate student majors can develop abilities to think critically, compare logically, decide independently, solve problems rationally and to communicate effectively in the formal course-work offerings. Additionally, though, livestock, meat and wool judging/grading/evaluation experiences provide opportunities for students to develop further those skill-sets, while simultaneously developing leadership skills. To qualify as an "educated" baccalaureate degree graduate, is it really important that a person be able to judge a class of stallions, assign Quality/Yield Grades to a beef carcass, grade a fleece or determine IMPS compliance of a pork loin? Yes, because those who pursue a career in animal agriculture will then be able to describe/discuss intelligently the industry's products and endproducts. But even if a person never intends to, and

does not, pursue a career related to animal agriculture, there are huge personal benefits which accrue from learning the principles involved in mastering the generalities, concepts and specifics of the art and science of judging, grading and evaluation. Development of skills in comparative reasoning, application of memory standards, mental gymnastics, independent problem-solving, knowledge integration, written/oral communication and leadership will prove useful irrespective of one's career path. Animal science department administrators must insist that, within the B.S. curricula, there are opportunities for students to participate in clubs and intercollegiate competitions to serve as an integral part of the process of developing leadership skills.

Key Words: Leadership, Curriculum, Judging teams

992 Techniques and philosophy for training students to grade carcass beef. J.W. Wise*¹ and H.G. Dolezal², ¹USDA, Agricultural Marketing Service, ²Excel Corporation.

Students who are effective in grading beef carcasses for quality grade and yield grade are often successful in overall judging because the skills needed to evaluate grade traits are relevant across species and product lines. Initially, the basics of beef grading should be presented to students with visual aids and actual carcasses to demonstrate the range and variation in skeletal and lean maturity, marbling, lean firmness, internal and external fatness with and without adjustments, and longissimus muscle (LM) size across a range of carcass weights. Once students understand the key factors and the necessary calculations to combine these factors for both quality and yield grading then a session with probes, grids, and marbling cards may be used to test their ability to physically measure or evaluate each factor. Early training for students to call the factors without the use of mechanical aids is best accomplished concentrating on one trait at a time (i.e., call LM area on 15 carcasses and review; then actual preliminary yield grade (PYG) and review, then adjusted PYG, etc.). Encourage students to develop a sequence of practices that work for them to avoid oversights during appraisal. Key factors to consider include the amount of light available and the distance for eye contact they may have for evaluating individual traits. Quality grade training should focus on the lines of transition for each of the factors (marbling score, skeletal maturity, and lean maturity). Students should be trained as individuals to refine their skills for problem traits or ranges within a trait. At each grading exercise, students should be encouraged to begin their evaluation using a carcass with traits that they are most confident in estimating (i.e., small00 marbling. 80.6 sq cm LM area, etc.). Repetition is critical to instill the self-confidence needed by students to grade beef. Instructors are encouraged to involve students in obtaining individual measurements, computing official results, to discuss results while viewing carcasses and to encourage discussion.

Key Words: Beef, Carcass, Education

993 Effectively teaching meat judging specifications. Duane Wulf*¹ and Gretchen Hilton², ¹South Dakota State University, ²Texas Tech University.

The specifications used in Intercollegiate Meat Judging are based on the IMPS specifications. However, these specifications have been modified slightly from the official IMPS specifications to make them more usable in the competitive environment of a meat judging contest. In preparing students to be proficient in a specifications class in a meat judging contest, you should teach them the following steps: 1) memorization, 2) interpretation, 3) application. The specifications class can be the most frustrating aspect of meat judging to a beginning meat judge because of the vast amount of information that must be memorized; however, the class can be one of the most rewarding aspects of meat judging to an experienced meat judge because a perfect score of 100 is a challenging, yet attainable, goal. The first step in mastering the specifications class is to memorize them. A student must not only memorize the specifications but must also memorize the corresponding defect codes on the answer card. This memorization is easier and much more effective if the student has seen the actual meat cuts and understands how the cuts are fabricated from the carcass. The second step in mastering the specifications class is being able to interpret the specifications as they relate to acceptable and unacceptable meat cuts. A student must know specifically where to look on a certain cut to ascertain the adherence to a certain specification. A student must be aware of the different situations that are acceptable and those that are unacceptable. Lastly, a student must learn how to apply the specifications in a contest setting. In a contest setting, a student cannot use any measurement tools, cannot touch any of the meat cuts and has no help from anyone else. Therefore, a student must be confident about their knowledge of the specifications and must rely on that confidence and previous training in order to be successful in a contest specifications class. This confidence comes from being prepared and from practicing. Students who study and practice to prepare themselves for the specifications class will not only learn much about the skeletal and muscular anatomy of meat animal carcasses, but will also learn a great deal about a very important every-day aspect of the meat industry.

Key Words: Meat evaluation

994 Coaching to Succeed: Effective Strategies for Answering Questions in Meat Evaluation. R M Harp*¹, R C Hines¹, and R D Stites², ¹Tarleton State University, ²Eastern Oklahoma State College.

It has been said that there is no substitute for hard work. The ability to think critically and discern differences in meat judging gives the student a definite edge when the decision-making processes occur in real-world situations. Many hours should be spent recruiting and informing the administration of the benefits of an activity such as meat judging. Yet, after this task has been accomplished, we can get into the nuts and bolts of teaching and preparing students to perform at a high level of answering questions. The key factors that must be completed with this high level of precision are understanding proper terminology, understanding the concepts of quality and cutability, possess a competitive nature, be willing to give the proper time on task, concentration (focus). Many coaches recruit good students and teach the fundamentals, yet students fail to fully concentrate 100 %, and follow a methodical procedure. Furthermore, the successful coach needs to understand that students have various learning styles. Let us note at the onset that note-taking for questions is different than that for reasons in most cases. Reasons are comparative with each of the three pairs and is descriptive for the last carcass or cut, whereas, questions are more holistic in that they are descriptive for the entire class. Notes for questions are to observe and identify the major points for placing the entire class according to quality and cutability as well as understand the reasoning for placing the class. Secondly, organize the notes in a manner in which the student can read the notes and make a mental picture of the class. In preparing for questions, remember take notes on the big differences first and work your way down. We should aim for one hundred percent, but at least 75-80% of the questions will pertain to the distinguishable differences that was used to place the class. As in both reasons and questions the student's notes should "Paint the picture of the class". This is a critical part of answering questions. Lastly, it is imperative that team members are involved each week throughout the year in preparing for questions. Repetition and concentration are the vital determinants for success and consistency in answering questions.

Key Words: Note-taking, Terminology, Time-on-task

995 Team behavior; at home, on the road, in the plant, at the contest and after the contest. P.T. Berg*, North Dakota State Univ..

The key to student conduct (behavior) can be summarized in a single word: RESPECT. North Dakota State University, College of Agriculture installed an "honor code" system in the late 1950's. Faculty involved with the judging teams try to use the ethical basis for this code in all aspects of student teaching. The intent of the honor code is to place the responsibility for the demonstration of individual effort directly on the student (and their peers) rather than be monitored by an authority figure. The coaches introduce the concept of individual responsibility early and often. It is an easy, logical step to ingrain both the meaning and the philosophy of respect into student thinking. In order to be used for behavioral modulation in team members, five levels of respect, in rank order of importance, are addressed: (Respect) 1. for themselves; 2. for their teammates; 3. for the judging program, (a. at the individual university; b. judging in general); 4. for our hosts; and 5. for the coach. If, through training (and insistence of the coach), respect at all levels is part of the team philosophy, behavior problems are minimal. Discipline of an individual's behavioral breaches are first through peer oriented loss of respect from teammates and contemporaries, which at this age for the average team member, is a powerful motivation. If the coach has clearly established the program's expectations, is fair and consistent in dealing with all aspects of the judging team experience, there need be no role as a fear generating, rule-book adhering disciplinarian.

Key Words: Judging team behavior

The Role of Forages in Enhancing Food Safety and Quality and a Clean Environment

996 Forage feeding to reduce pre-harvest *E. coli* populations in cattle, a review. T. R. Callaway*¹, R. O. Elder¹, J. E. Keen², R. C. Anderson¹, and D. J. Nisbet¹, ¹USDA/ARS-Southern Plains Agricultural Research Center, College Station, TX, ²USDA/ARS-Meat Animal Research Center, Clay Center, NE.

Although *E. coli* are commensal organisms that reside within the host gut, some enteropathogenic strains of *E. coli* can cause hemorrhagic colitis in humans. The most notable enterohemorrhagic *E. coli* (EHEC) strain is O157:H7. Cattle are asymptomatic natural reservoirs of *E. coli* O157:H7; and it has been reported that as many as 30% of all cattle are carriers of this pathogen, and in some circumstances this can be as high as 80%. Feedlot and high-producing dairy cattle are fed high grain rations in order to increase feed efficiency. Because cattle have low amylase activity, much of the starch passes to the hindgut where it is fermented. EHEC are capable of fermenting sugars released from starch breakdown in the colon, and populations of *E. coli* have been shown to be higher in grain fed cattle, and this has been correlated with *E. coli* O157:H7 shedding in barley fed cattle. When cattle were abruptly switched from a high grain (corn) diet to a forage diet, generic *E. coli* populations declined 1000-fold within 5 days and the ability of the fecal generic *E. coli* population to survive an acid shock similar to the human gastric stomach decreased. Other researchers have shown that a switch from grain to hay caused a smaller decrease in *E. coli* populations, but did not observe the same effect on gastric shock survivability. In a study that used cattle naturally infected with *E. coli* O157:H7, fewer cattle shed *E. coli* O157:H7 when switched from a feedlot ration to a forage-based diet compared to cattle continuously fed a feedlot ration. Results indicate that switching cattle from grain to forage could potentially reduce EHEC populations in cattle prior to slaughter; however the economic impact of this needs to be examined.

Key Words: Forage, Cattle, *E. coli*

997 Keeping *Escherichia coli* O157:H7 Down on the Farm. M. P. Doyle*¹, ¹University of Georgia.

E. coli O157:H7 is responsible for an estimated 73,500 cases of infection in the U.S. annually, with principal vehicles of transmission being beef, produce, water (both drinking and recreational), and cattle (handling). *E. coli* O157:H7 is carried in the intestinal tract of cattle and the pathogen's most frequent origin is direct or indirect contact with cow manure. Manure can contaminate food when used as a soil fertilizer, when it pollutes irrigation water, when cattle defecate near produce or foods of animal origin, and when intestinal contents or manure-laden hides contact carcasses during slaughter and processing. Case-control studies of patients with *E. coli* O157:H7 infections revealed that eating undercooked ground beef, living on or visiting a farm, and contact with farm animals, especially cattle, are major risk factors associated with acquiring *E. coli* O157:H7 infections. An estimated 1.36 billion tons of animal manure is produced in the U.S. annually, with greater than 90% attributed to cattle. An effective control program to substantially reduce *E. coli* O157:H7 infections will require the implementation of intervention strategies throughout the food continuum, from farm to table. Promising intervention measures at the farm include competitive exclusion bacteria, bacteriophage, innovative vaccines, and targeted animal management practices addressing common points of contamination. Most promising of these to date is competitive exclusion bacteria of which 80 to 90 percent of cattle administered probiotic *E. coli* was rid of *E. coli* O157:H7 within ca. 2 weeks posttreatment.

Key Words: *E. coli*, beef, contamination

998 Role of diet on conjugated linoleic acid content of milk and meat. T. R. Dhiman*¹, ¹Department of Animal, Dairy and Veterinary Sciences, Utah State University, UT 84322-4815.

Conjugated linoleic acid (CLA) occurs naturally in many foods. However, the principal dietary sources are meat, dairy products and other foods derived from ruminants. Research studies with animal models suggest that CLA reduces the risk of cancers at several sites (mammary tissue, prostate, gastrointestinal tract, lung, and skin), reduces body fat and enhances growth of lean body mass. Current knowledge suggests that the *cis*-9, *trans*-11 CLA isomer is probably responsible for anticancer effects, while the *trans*-10, *cis*-12 CLA isomer induces body

composition changes. Milk fat CLA is 92% *cis*-9, *trans*-11 and contains no detectable *trans*-10, *cis*-12 CLA. However, beef fat has an average 78% of the total CLA as *cis*-9, *trans*-11 and 22% *trans*-10, *cis*-12 CLA. Fat from milk and beef contains an average 4.0 and 3.5 mg CLA/g of fat, respectively. Current research suggests that CLA in meat and milk fat of ruminants originates from two sources: 1. From incomplete ruminal biohydrogenation of lipids, 2. Endogenous synthesis from *trans*-11 C18:1 fatty acid. The delta-9 desaturase enzyme is responsible for the conversion of *trans*-11 C18:1 in the mammary gland. Research review shows that diet and management practices can influence the CLA content of milk and meat. Cows grazing on pasture had 500% more CLA content in milk compared with cows fed typical dairy cow diets containing conserved forage and grain in a 50:50 ratio. Feeding oils such as soybean, sunflower, peanut, linseed and fish oil to dairy cows can increase the CLA content of milk. Feeding full fat extruded soybeans and cottonseed to dairy cows doubled the CLA content of milk and cheese compared with feeding normal diet. Other factors such as feeding high grain diets and reducing the forage particle size will decrease milk fat CLA. Feeding up to 5% soybean oil to feedlot beef cattle during finishing period resulted in a small increase in CLA content of beef. Beef from steers raised on forages had 550% more CLA *cis*-9, *trans*-11 isomer, whereas steers receiving grain in back-grounding and grazed on pasture with no grain supplementation during finishing period had only 300% more CLA compared with beef from steers fed typical feedlot high grain diet. Raising beef cattle on forages and pasture with no grain supplementation can enhance the CLA content of beef.

Key Words: CLA, Milk, Meat

999 Physiological and productive responses of dairy cows to intake and characteristics of fiber. D. Savant*¹ and D.R. Mertens², ¹INRA-Institut National Agronomique, Paris-Grignon, ²US Dairy Forage Research Center, Madison, WI.

Numerous studies have dealt with the influence of chemical and physical fiber in the diet on intake, chewing activities, digestion, metabolism and milk secretion. A database compiled from these experiments was analyzed statistically to extract multiple marginal responses of cattle to dietary fiber. The database consisted of 179 experiments (446 treatments) related to NDF or concentrate proportion in dietary DM and 53 experiments (82 treatments) dealing with the influence of dietary mean particle size (MPS). Data were analyzed with the GLM procedure to investigate relationships across and within experiments. Intake was significantly depressed as dietary NDF increased. Chewing activities decreased as dietary NDF and MPS decreased. Rumen contents were influenced by NDF intake, but not by MPS. Ruminant parameters (pH, VFA contents and profile, microbial growth, etc.) were affected in a similar manner by both NDF and MPS. These responses were consistent with data on chewing activities. Organic matter digestibility and net energy concentration were altered by dietary NDF and DMI. Raw milk yield was depressed as dietary NDF increased. Milk protein and lactose percentages were decreased at a similar rate when dietary NDF increased while the opposite occurred for milk fat percentage. Milk fat was also highly dependent on MPS. In the total database, there was consistency between milk fat percentage and parameters of digestion in the rumen, particularly pH and acetate/propionate ratio. The responses of milk secretion to dietary energy supply were studied in experiments where OM digestibility was measured. It appeared that responses of milk protein, lactose and raw yield were linear functions of energy supply, whereas the response of fat secretion was curvilinear. These responses to dietary fiber contribute quantitatively to the current debate about the concept of effective fiber in dairy cows. Meta-analysis can be used to indicate threshold values for dietary characteristics that can maintain animal health and product quality.

Key Words: Ruminant pH, Fiber, Particle size

1000 Impacts of livestock forage and pasture use on carbon sequestration and greenhouse gas emissions. D.E. Johnson*, H.W. Phetteplace, A.F. Seidl, and R. Conant, *Colorado State University, Ft Collins, CO.*

Representative models of U.S. dairy (WI, CA) and beef (AL, TX, UT, VA, WI) production systems were constructed to sum the land use requirements, greenhouse gas (GHG) emissions and product outputs. Total GHG emissions expressed, as CO₂ equivalents per unit of milk were 1.4 and 1.5 kg/kg, while the production of beef as live weight at the farm gate resulted in from 13.8 to 18.2 kg/kg. The 2 dairy systems utilized 0.6 (CA) and 1.1(WI) ha of land per mature cow unit. Beef systems', including stocker and feedlot, land use was projected to range from 1 to 3.7 ha per mature cow unit. Best management practices applied to all land used in these operations is expected to store .12 and .22 Mg/cow unit for dairy systems and from .2 to .7 Mg of carbon/beef cow unit, anywhere from 4 to 50% of total system GHGs. Twenty-yr

simulations of soil C were run using the Century model for 7 to 10 soil types in 3 locations assuming normal tillage operations. Changing from pasture to either hay or various grain cropping regimens generally decreased soil-C (av. -0.25 Mg/ha/yr), however, the changes were quite variable by soil type. The reverse simulation, change from grains or hay to pasture, at the third location showed wide variations also but averaged +0.28 Mg/ha/yr. Thus changing to increased pasture usage could yield additive C sequestrations above those realized from BMP's. Potential grazing land C-sequestration in the U.S. has been estimated at 4 fold the total agricultural grazing land GHG emissions. Caution must be exercised since tradeoffs, as will be discussed, can occur e.g., if reduced rate of production increases CH₄/product or excess forage N enhances N₂O emissions. Also, long term measurements of soil C in intensively managed pastures can show C losses as noted for a location in NZ.

Key Words: Pasture and forage, Carbon sequestration, Greenhouse gases

ASAS/ADSA Breeding and Genetics: Genetic Parameters of Beef Cattle

1001 Development and use of genetic markers to predict marbling and tenderness in beef cattle. F. L. Fluharty* and D. J. Jackwood, *The Ohio State University, Wooster, OH.*

Detecting animals with the genetic potential for superior performance or meat characteristics requires identifying those genes controlling the desired traits. Since identifying the genes controlling performance and meat characteristics is not practical at this time, genetic markers are used. These markers are used to identify a specific location, or loci, on an animal's chromosome. The key to developing a useful genetic marker is to find one that identifies the specific loci of genes responsible for the trait of interest. We have used the random amplified polymorphic DNA (RAPD) assay to identify two markers that correlate highly with marbling and four markers that correlate highly with tenderness in crossbred beef cattle. Diagnostic tests for these markers that are ultimately developed for commercial use must be relatively low cost, extremely reliable, and logistically appropriate to allow for large numbers of samples to be analyzed in a short period of time. Once an animal's genetic potential is known, management and nutritional strategies must be developed to target the animal toward a known outcome or consumer group. From the standpoint of the seedstock sector, knowing the genetic result of a planned mating shortly after the calf's birth could enhance genetic selection. Feeder calves could be sold in genetically similar groups that are targeted toward a specific consumer group and managed in the feedlot to achieve their potential. The widespread use of genetic technology could lead to a formalized market system in the cattle industry.

Key Words: genetics, markers, beef

1002 Evidence for an association between a *Hind III* PCR-RFLP of the bovine insulin-like growth factor binding protein-2 (IGFBP-2) locus and growth and carcass traits in beef cattle. M. Pagan*, J. Cowley, N.E. Raney, and C.W. Ernst, *Michigan State University, East Lansing.*

Insulin-like growth factor binding protein-2 (IGFBP-2) was selected as a candidate gene for growth and carcass merit in beef cattle. Simmental (n = 21), Shorthorn (n = 13), Tarantaise (n = 7), Angus (n = 17), Hereford (n = 17), Salers (n = 5), Red Angus (n = 1), MARC II (n = 8), and Maine Anjou (n = 11) sired cattle were genotyped for an IGFBP-2 *Hind III* RFLP that was previously identified in our laboratory. Two alleles were found to be segregating in all breeds with frequencies of 0.14 A/0.86 B for Simmental, 0.59 A/0.41 B for Hereford, 0.15 A/0.85 B for Angus, 0.3 A/0.7 B for Salers, 0.31 A/0.69 B for Shorthorn, 0.5 A/0.5 B for MARC II, 0.54 A/0.46 B for Maine Anjou, 0.5 A/0.5 B for Red Angus and 0.07 A/0.93 B for Tarantaise sired cattle. Data from the Hereford, Shorthorn and Maine Anjou breeds (AA, AB, BB genotypes represented) was analyzed for possible associations between IGFBP-2 genotypes and growth and carcass traits. A statistically significant effect of genotype (P < 0.05) was found for days on feed, hot carcass weight, dressing percentage, trimmed hot carcass weight, cold carcass weight, ribeye area and USDA yield grade. Animals with the BB genotype had fewer days on feed, higher hot carcass weight and higher dressing percentage than those with the AB genotype (P < 0.05). No significant differences were observed between AA and BB individuals or

between AA and AB individuals for these traits (P > 0.05). For trimmed hot carcass weight and cold carcass weight, the AA and BB genotypes represented the animals with higher weights in relation to the heterozygous (AB) animals (P < 0.05). The BB individuals had higher ribeye areas and better USDA yield grades than the AA and AB animals (P < 0.05). Therefore, animals with the BB genotype appear to have more desirable growth and carcass characteristics. Results of this study indicate that an association may exist between alleles of the IGFBP-2 gene and growth and carcass traits in beef cattle. Validation of these results in additional populations is warranted.

Key Words: PCR-RFLP, IGFBP-2, Growth

1003 Effects of selection for yearling ultrasound intramuscular fat percentage in Angus bulls on carcass traits of progeny. R. L. Sapp*, J. K. Bertrand, and T. D. Pringle, *University of Georgia, Athens.*

Twenty-one Angus bulls from three purebred farms were used to determine the effects of selection for phenotypic yearling ultrasound intramuscular fat percentage (USIMF) on the carcass traits of steer progeny managed for commercial slaughter. Bulls were selected based on their high or low phenotypic USIMF within a contemporary group. Average USIMF was 4.01% (SD = 1.07, n = 10) and 1.59% (SD = 0.53, n = 11) for high USIMF (HU) and low USIMF (LU) line bulls, respectively. Each bull was randomly mated to a group of 14 to 30 purebred Angus females for 1 to 5 years. One bull from the HU and one bull from the LU were used throughout the project. Birth weight, weaning weight, yearling and carcass weight, fat thickness at the 12th rib (FAT), longissimus muscle area at the 12th rib (REA), and marbling score (MB) measurements were taken on 196 steer progeny. Carcass data were linearly adjusted to 480 d of age at slaughter. Fixed effects for all traits were birth year of calf, phenotypic USIMF line of sire, and interaction between year and line. Sire, nested within year and line, was included as a random effect. Progeny data were analyzed using the MIXED procedure of SAS. Least squares means of progeny sired by HU (LU) bulls for MB and quality grade (QG) were 447.16 ± 10.13 (408.19 ± 10.09) and 606.23 ± 5.30 (585.09 ± 5.29), respectively, where MB of 400 = small and QG of 500 - 599 = Select, 600 - 699 = Choice. Birth weight (P < 0.05), MB (P < 0.02), and QG (P < 0.02) were found to be larger in steers sired by HU bulls. Longissimus muscle area was larger (P < 0.02) for steers sired by LU bulls. Sire selection based on USIMF was effective in increasing MB and QG in steer progeny. These results suggest that yearling bull ultrasound measurements can be used as selection criteria for genetic improvement of steer carcass traits, and selection for higher levels of marbling can be obtained without increasing fat thickness.

Key Words: Ultrasound, Intramuscular Fat, Selection Response

1004 Estimation of heritability for serially measured ultrasound fat thickness and percentage of intramuscular fat in Angus cattle using random regression models. A. Hassen*, D. E. Wilson, and G. H. Rouse, *Iowa State University, Ames, IA, USA.*

The present study included serially measured ultrasound fat thickness (FTK) and percentage of intramuscular fat (PIMF) measures from 423 purebred Angus bulls and heifers. Cattle were born during the spring of 1998 and 1999 at Rhodes beef research farm. Each year, bulls and heifers were scanned four to six times for FTK and PIMF starting at an age of 180 to 269 days, with 30 to 40 days interval between scans. The objective of this study was to evaluate the general trend in heritability and variance component estimates for FTK and PIMF measures spanning ages at measurements. Initially, FTK and PIMF observations from each scan session were analyzed using single-trait animal model. In further evaluation, data were subjected to random regression (RR) models that included fixed effects of contemporary group as well as a linear and quadratic regression on orthogonal polynomials of age. Random effects considered were RR coefficients on orthogonal polynomials of age for each of animal direct genetic and permanent environmental effects. For both traits measurement error variances were assumed independent and homogeneous across ages. Heritability of FTK increased from 0.16 at 196 days age to 0.45 at ages 413 to 441 days. Similarly, heritability of PIMF increased from a minimum of 0.39 at 217 to 266 days of age to a maximum of .58 at 441 days of age. Heritability and repeatability of FTK at one year of age were 0.41 and 0.79, respectively. The corresponding values for PIMF were 0.49 and 0.70, respectively. Heritability estimates from single trait analysis were similar when compared at measurement ages of the respective sessions. Permanent environmental variance contributed to a relatively large proportion of the phenotypic variance for FTK measures ranging from 22.1% to 47.3%, as compared to 21% to 27.7% for PIMF measures. The results suggest that individual selection based on FTK at earlier ages may not be effective due to a large contribution of non-genetic effects to the total phenotypic variance.

Key Words: Composition, Ultrasound, Heritability

1005 Use of repeatedly measured ultrasound percentage of intramuscular fat data to evaluate individual animal rankings. A. Hassen*, D. E. Wilson, and G. H. Rouse, *Iowa State University, Ames, Iowa, USA.*

This study used serially measured percentage of intramuscular fat (PIMF) measures of 82 purebred Angus bulls born in the spring of 1999 at Rhodes beef research farm. Bulls were serially scanned six times for PIMF by a certified technician starting at an age of 180 to 254 days. Intervals between scans ranged from 27 to 40 days and at each session all cattle were scanned twice at two consecutive days (day-I and II). The objective of the study was to compare overall and individual animal ranking for PIMF based on day I and II measurements at each session. The overall mean PIMF values for scans one to six were 3.01, 3.65, 4.10, 4.25, 4.47, and 4.96%, respectively. The absolute difference between day I and II for scan sessions one to six were 0.47, 0.67, 0.62, 0.66, 0.62, and 0.63%, respectively. Repeatability of PIMF values increased with scan session ranging from 0.41 at the second scan to 0.72 at the sixth. A similar analysis of pooled data using random regression model showed a general increase in repeatability values with age ranging from 0.63 at ages 252 to 287 days to a maximum of 0.79 at ages 427 to 441 days. Individual animal curves based on mean values of day I and II of each session often provided a clear view of changes in PIMF than separate plots from the respective days. When PIMF values were compared to carcass intramuscular values, day II measures showed less bias (0.55% vs. 0.58%), absolute difference (0.90% vs 1.00%), and a better rank correlation (0.75 vs. 0.66) and root mean square error (0.96% vs. 1.09%) than measurements taken on day I. In trials involving evaluation of individual animal body composition in young cattle using relatively small sample size, taking PIMF measurements from each animal at two consecutive times (days) for each session may provide a better view of trends.

Key Words: Ultrasound, Intramuscular fat, Beef Cattle

1006 Heritability estimates of visceral fat weight. L. S. Gould*¹, J. A. Marchello², and S. K. DeNise², ¹*Red Angus Association of America, Denton, Texas,* ²*University of Arizona, Tucson, Arizona.*

Heritabilities were evaluated for body composition traits on calves sired by two different groups of bulls. One group of bulls (AHA) were registered with the American Hereford Association and were representative of the Hereford breed in the U.S. The other group of bulls (SCA) came from a closed herd on the San Carlos Apache Reservation in central Arizona that has been selected for 34 years to perform in a nutritionally stressful environment with no supplemental feed. Over a period of three breeding/calving seasons, 127 calves were produced from artificial matings with these sires and raised in adequate nutritional environments. Calves were fed, post weaning, to maximize gain and were slaughtered at constant weight: 520 kg for bulls, 450 kg for heifers. Bull calves remained intact the first season, but were castrated subsequently. Traits analyzed included rib eye area (RE), 12th rib back fat (BF) and visceral fat weight (VF). Differences in VF have been hypothesized to indicate differences in energy requirements for maintenance and/or growth. Because of limited data, genetic correlations and maternal effects were not estimated. All traits were analyzed using the derivative free restricted maximum likelihood procedure. Models to evaluate heritability of RE and BF included sex, and season as fixed effects. Random components included additive genetic and residual effects. Age at slaughter (SLA) for these traits was used as a covariate due to common industry practice. Heritabilities for RE and BF were .39 and .29 respectively. Because BF and RE heritability estimates are similar to estimates from other sources, the data structure of this study, although small, may be appropriate for estimating heritability of VF. Three models, differing only by which covariate was included, were used to evaluate VF. Covariates included SLA, 12th rib back fat and none. Using SLA or no covariate produced similar results with $h^2 = .10$. Using a BF covariate, $h^2 = .35$. Heritability estimates indicate that differences in VF are likely to be heritable and could enhance future predictions of genetic merit for energy requirements in beef cattle.

Key Words: Heritability, Body composition, Energy utilization

1007 Simulation of economic responses to simulated selection for increased conception rate in beef cattle. Lowell Gould*¹ and Dale VanVleck², ¹*Red Angus Association of America, Denton, Texas,* ²*USDA, ARS, MARC, Lincoln, NE.*

A stochastic simulation program was developed to quantify differences in herds of commercial beef cattle using bulls from sire lines with different genetic trends for conception rate. Breeding values were simulated for 15 traits. Conception rate (CR) and calving difficulty were modeled as threshold traits. All genetic change in commercial herds came through selection of male seed stock from sire lines with either positive conception rate (genetic) trends or no trend (NT). Income was derived from sales of weaned steer calves and cull animals. All heifer calves were retained through winter. Herds that utilized bulls from positive CR trend, had breakeven prices that were smaller by \$0.30/kg ($P < .01$). Selection for increased conception rate increased pregnancy rate by 8.0% ($P < .01$) after 25 years of selection. Increased pregnancy rate directly affected subsequent weaning rates by 9.3% ($P < .01$) between the two herds, making that herd more biologically efficient on the basis of calves weaned per cow exposed basis. However, cows were culled before calving only if they were not pregnant. Therefore, the higher pregnancy rate caused more mature cows to be retained over winter. Total body weight of all cows wintered was 161,529 kg for 350 cows in the high fertility herd and 150,558 kg in the commercial herd with no increase in conception rate ($P < .01$). Because feed consumption was based on weight of each animal, more feed was required in the high conception rate herd causing increased feed costs. Although pounds per calf weaned did not differ between the herds, the additional calves gained from increased conception rates were significant enough to overcome increased feed costs by \$12 per cow ($P < .01$). Birth weight per calf was not significantly different between the two herds, but number of assisted calvings was greater by 1.6% ($P < .01$) in the NT herd due to the different age distributions. The simulation model successfully predicted differences between selection strategies which may allow improved management decisions.

Key Words: Economics, Fertility, Management

1008 Genetic correlations between mature and birth or weaning weights of Hereford cattle. J. M. Rumph*¹, R. M. Koch¹, K. E. Gregory², L. V. Cundiff², and L. D. Van Vleck^{2,3}, ¹University of Nebraska, Lincoln, NE, ²USDA, ARS, USMARC, ³Clay Center, NE, ³Lincoln, NE.

The genetic correlations between mature weight (MW) measured at three different times per year and birth (BW) or weaning weight (WW) were estimated. The data were from a control and three selection lines, selected for weaning weight, yearling weight, and an index of yearling weight and muscle score. Weights available were taken at brand clipping (generally before calving, 1123), at breeding (1537), and when calves were weaned and when cows were pregnancy checked (573). Bivariate analyses of data from all lines were performed that paired a single seasonal MW with one of the immature weights. The one MW was taken when the cow was 6-, 7-, 5-, or 8-years-old. For MW, the model included fixed effects of year by age by line, age of dam by line (DAXL), pregnancy status by line, and birth and method of rearing of calf by line. A covariate for the interval between when the weight was measured and when the cow calved was also fit to the data. For BW (11,313 records) and WW (10,011 records), the model included fixed effects of DAXL, birth and method of rearing by age of dam by year of birth, and sex by age of dam by year of birth. A covariate for Julian birth date was also used. Random direct genetic, maternal genetic, and maternal permanent environmental effects were included in the model. Estimates of correlations between MW and BW ranged from .56 to .69 for direct and -.05 to .84 for maternal genetic effects. Estimated correlations between MW and WW ranged from .64 to .73 for direct and .50 to .91 for maternal genetic effects. Estimated correlations between maternal permanent environmental effects were from .00 to .53 between MW and BW and from .78 to .99 for MW and WW. Selection to reduce BW would be expected to decrease MW and selection to increase WW would be expected to increase MW. An index including BW, WW, and MW would be needed to optimize total productivity.

Key Words: Growth, Weight, Beef Cattle

1009 Effect of separating contemporary group by age of dam in Simmental genetic evaluation. Z. Zhang*, E.J. Pollak, and R.L. Quaas, Cornell University.

Young cows are frequently managed differently than older cows. If progeny records of heifers and cows are improperly assigned to the same contemporary group (CG) this can create a CG by age of dam interaction that is not modeled. To ensure that this does not happen, age of dam is made part of the CG definition. This will eliminate potential bias but at the expense of increased variance due to many more contemporary effects and fewer data (loosing connection). A comparison study was done with 3,337,268 records extracted from American Simmental Association (ASA) database on calves born between 1968 and 1999. The CG in 'combined' CG model was defined as in current genetic evaluation of ASA. For 'split' CG model these were separated by age of dam: greater (less) than 990 days. There were 20.3% of the calves out of young cows. Separating CG by age of dam increased number of CG (22.3%, 26.3% and 18.7 for BWT, WWT, and YWT respectively), and decreased numbers of records accepted (4.0%, 4.4% and 5.2% for BWT, WWT, and YWT, respectively). Numbers of sires, dams and nonparents decreased 4.1%, 2.9% and 2.7%, respectively. The EPD differences (combined minus split) were investigated for 10027 bulls with at least ten calves. The correlation between EPD differences and the percentage of calves out of two year old dam were negative for BWT, WWT and YWT (-0.08, -0.11 and -0.11), and positive for milk (0.05).

P	N	Mean difference ± Se (Kg)			
		BWT	WWT	YWT	Milk
0.0-0.2	3041	-0.01±0.00	+0.01±0.02	+0.07±0.03	0.15±0.02
0.2-0.4	3501	-0.01±0.00	-0.04±0.02	+0.00±0.03	0.23±0.02
0.4-0.6	1451	-0.04±0.01	-0.15±0.05	-0.19±0.07	0.21±0.02
0.6-0.8	800	-0.05±0.02	-0.33±0.08	-0.50±0.11	0.23±0.03
0.8-1.0	1234	-0.08±0.02	-0.56±0.08	-0.75±0.11	0.32±0.03
Total	10027	-0.02±0.01	-0.13±0.02	-0.14±0.03	0.21±0.01

P is percentage of calves out of two year old dams; N is number of bulls in each category.

Key Words: Age of dam, Contemporary group, Simmental

1010 Experimental selection for reduced calving difficulty: estimated breeding value trends. G. L. Bennett*, USDA, ARS, US Meat Animal Research Center.

Heifer calving difficulty is heritable but unfavorably correlated with growth. The objective of this experiment was to evaluate multiple-trait genetic evaluation as a tool for simultaneously reducing calving difficulty and maintaining growth. Select and control lines were established in four purebred (Angus, Charolais, Gelbvieh, and Hereford) and three composite (MARC I, MARC II, and MARC III) populations. The select line goals were reduced heifer calving difficulty and average yearling weights. Control line goals were average birth and yearling weights. Average weights for purebreds were defined as industry average EPD. Selection was based on EPD for heifer calving difficulty score and yearling weight EPD in select lines, and birth and yearling weight EPD in control lines. Four phenotypes (heifer calving difficulty score, birth weight, weaning weight, and yearling weight) were used to compute the multiple-trait EPD. During seven years of selection, 6,888 calves were born to 353 select sires and 2,033 calves were born to 237 control sires. Calving difficulty scores were recorded on 1,807 select and 560 control calves born to 2-yr-old dams. Estimated breeding values (EBV) in the table below show strong trends for improved direct calving difficulty score and lower direct genetic birth weight and no trend in yearling weight. For calves born in 1998 and 1999, more control calves (36%) than select calves (15%) born to heifers required assistance ($P \leq .01$). Results show that substantial genetic change in heifer calving difficulty can be made while maintaining growth to yearling age.

EBV	1993	1994	1995	1996	1997	1998	1999
Calving Difficulty Score							
Direct	-0.33	-0.65	-0.74	-0.83	-0.99	-1.06	-1.03
Maternal	0.04	0.08	-0.02	0.09	0.00	-0.08	0.01
Birth Weight, kg							
Direct	-1.10	-2.11	-2.49	-2.76	-3.37	-3.48	-3.55
Maternal	0.17	-0.20	0.05	-0.11	-0.32	0.00	-0.24
Yearling Weight, kg							
Direct	3.0	-2.9	0.2	-0.4	-2.9	2.1	-1.8

Key Words: Calving difficulty, Selection, Breeding value

1011 Nonlinear relationship between birth weight and calving ease determined with ecological analysis in a multi-breed commercial beef herd. Y. Wang*, S.P. Miller, J.W. Wilton, P. Sullivan, and L.R. Banks, University of Guelph, Guelph, Ontario, Canada.

Ecological analysis were applied to a multi-breed commercial beef herd to examine the non-linear relationship between birth weight (BW) and calving ease (CE). Data included 133,280 records on both BW and CE for calves born between 1986 and 2000. Based on the assumption of normality and homogenous residual variances, Snell Scores were calculated by combining individual CE, age of the dam, sex of calf and mating liability (ML) of parents. ML of parents involved five categories with thresholds -1.0, -0.2, 0.2 and 1.0 based on the standardized difference between standardized sire BW ABC (Across Breed Comparison) and standardized dam yearling weight ABC. Ecological correlations, as a correlation of averages, between BW and percent of un-assisted calving and between BW and Snell Score were -0.7399 and -0.7611, respectively. A quadratic regression model described the relationship between BW (independent) and percent of un-assisted calving (dependent) explaining 87% of the variation in CE. It was evident that BW is a major indicator of CE. Snell Scores retained the nature of CE while converting the categorical record to a continuous variable. At a given BW, age of the dam was a larger source of variation for CE than sex of calf and ML of parents. For a 2-year-old dam, 90% or more calving would be expected to be un-assisted in calf weighing 22-35 kg. With age of the dam increased to 3 years and more, the same level of CE can be achieved with a broader range of BW (20-45 kg). However, Pearson correlation of -0.1930 between BW and Snell Score indicated ecological correlations cannot be extrapolated to individuals due to variation in CE with a BW category. Regression coefficients calculated enable more accurate prediction of calving difficulty with changing BW across age of dam and sex categories.

Key Words: birth weight, calving ease, beef cattle

1012 Genotype by country interactions for growth traits in Charolais populations across four countries. K. A. Donoghue* and J. K. Bertrand, *University of Georgia, Athens GA.*

The importance of genotype by country interactions was evaluated for data from Charolais associations in Australia (AUS), Canada (CAN), USA and New Zealand (NZ). Data were composed of edited birth and weaning weight and postweaning gain records from the four countries. Only herds with more than 500 trait records, with an average contemporary group size greater than 9 animals, and that had trait records from progeny of 66 international sires were used in this study. Pairwise country samples were created that ranged from 20000 to 30000 trait records and a multiple trait animal model that considered each trait as a different trait in each country was used to estimate parameters in each pairwise analysis. Direct and maternal (in parentheses) estimated genetic correlations for birth weight for AUS vs. CAN, AUS vs. USA, USA vs. CAN, NZ vs. CAN and NZ vs. USA were 0.88 (0.86), 0.85 (0.82), 0.88 (0.82), 0.85 (0.83), and 0.84 (0.80), respectively. Direct and maternal (in parentheses) estimated genetic correlations for weaning weight for AUS vs. CAN, AUS vs. USA, USA vs. CAN, NZ vs. CAN and NZ vs. USA were 0.96 (0.91), 0.95 (0.90), 0.95 (0.91), 0.95 (0.92), and 0.95 (0.92), respectively. Direct estimated genetic correlations for postweaning gain for AUS vs. CAN, AUS vs. USA, USA vs. CAN, NZ vs. CAN and NZ vs. USA were 0.89, 0.91, 0.94, 0.90, and 0.91, respectively. Direct and maternal heritabilities were similar across all countries for birth and weaning weight, while direct heritabilities for postweaning gain in AUS and NZ were slightly lower than those in CAN and USA. The absence of genotype by country interactions observed in this study strongly indicates that a joint genetic evaluation for growth traits for Charolais populations could be conducted. A model that treated information from AUS, CAN, USA and NZ as one population, while adjusting for possible heterogeneous variances, could be implemented for this purpose.

Key Words: Genotype by Country Interaction, International Evaluation, Beef Cattle

1013 Evaluation of milk yield and udder characteristics in beef cows sired by high or low Milk EPD bulls. K. J. Stutts* and D. S. Buchanan, *Oklahoma Agricultural Experiment Station, Stillwater, OK.*

Maternal milk is an important influence on weaning weight that affects production efficiency in beef herds. The objective of this study was to evaluate High and Low Milk EPD sires for milk production and udder characteristics of their daughters. Cows used in this study were produced through the mating of Angus and Hereford bulls that differed in Milk EPD level to Hereford-Angus and Hereford-Angus-Brahman cows. They ranged in age from 7 to 11 yr old. All cows were bred by artificial insemination to South Devon bulls and calves were born in the spring from early February to early April. Milk production data were collected 7 times prior to weaning at 28 d intervals using the weigh-suckle-weigh method. The final milk production data corresponded to a 205-d weaning age for all calves. Udder measurements and scores were taken during periods 3 and 6 after complete removal of milk from the udder by suckling. Cows were restrained in a squeeze chute and visual conformation scores were given to each teat and the udder. Linear measurements were taken on the length of each teat, distance between the front teats, distance between the rear teats, and the diagonal distance from the left front to the right rear teat. Data were analyzed using least squares. Factors included in the model were breed, Milk EPD level, sex of calf, age of dam, and all two-way interactions. Age of calf was included as a covariate. High Milk EPD cows produced more milk than Low ($P < .05$), but there was not a difference ($P = .71$) in milk production between breeds. The interaction between breed and Milk EPD level was approaching significance ($P = .15$). Hereford sired cows had longer teat length ($P < .02$) and higher (more pendulous) udder scores ($P < .05$) than Angus. Low Milk EPD cows had slightly lower udder scores than High ($P < .10$). These results further confirm the utility of Milk EPD to predict milk production differences and provide only small evidence that there may be a negative effect on udder conformation for older High Milk EPD cows.

Key Words: Beef Cattle, Milk Production, Udder Characteristics

ASAS/ADSA Breeding and Genetics: Genetic Parameters of Dairy Cattle

1014 Possibilities for genetic improvement of fertility in US dairy cattle. K. A. Weigel*¹ and J. S. Clay², ¹*University of Wisconsin, Madison*, ²*Dairy Records Management Systems, Raleigh, North Carolina.*

Interest in improving conception rates has skyrocketed in recent years. Direct costs of poor fertility include increased semen costs, veterinary costs, days open, and involuntary culling. Indirect costs include reduced genetic progress due to a larger number of repeat inseminations and an increased proportion of pregnancies to genetically inferior natural service bulls. Selection for male (service bull) fertility is possible using Estimated Relative Conception Rate data from Dairy Records Management Systems. Service bulls are evaluated for 70-day non-return rate on first inseminations. Evaluations for all bulls with at least 300 inseminations in the past three years are published. Sire evaluations for female (daughter) fertility are not yet available, but a system is under development. Female fertility can also be measured as 70-day non-return rate; in this case male and female fertility can be analyzed jointly using a maternal effects model. Days to first insemination can also be evaluated, but measurements may be biased by the use of heat synchronization products. In a pilot study, male and female fertility were evaluated as 70-day non-return rate using 8.03 million insemination records from 1995 to present. The range in daughter fertility PTA for Holstein sires was roughly 10%, similar to the range in service bull fertility solutions. The correlation between male and female fertility solutions of Holstein sires was 0.02, and the correlation between female fertility and PTA milk was 0.09. Therefore, it will be possible to improve conception rates with little or no loss in genetic merit for milk yield by practicing secondary selection for male and female fertility. Fertility evaluations can be improved by increasing the quantity and quality of DHI insemination data, by utilizing repeat service data, and by considering models that account for the binary nature of the data.

Key Words: genetic selection, fertility, dairy cattle

1015 Effect of heat stress on Non-Return rate in Holstein cattle. O Ravagnolo and I Misztal*, *The University of Georgia, Athens, GA.*

The objective of this study was to examine the relationship between reproductive traits and heat stress. Non-return rate at 45 days (NR45) was analyzed in a fixed effect model that included Temperature Humidity Index from a nearby weather station as a measurement of heat stress. Data consisted of 150,200 first inseminations at first and later parities of 110,860 Holstein cows from 550 herds in Georgia, Tennessee and Florida with weather information from 16 weather stations. THI on the day of the insemination, 2 days prior, 5 days prior, 10, 20 and 30 days after insemination were studied as independent variables. THI on the day of insemination showed the highest effect on NR45, followed by 2 days prior, 5 days prior and 5 days after insemination, but no relationship was found with THI at 10, 20 and 30 days after insemination. NR45 showed a decrease of 0.005 per unit increase in THI on the day of insemination for THI > 68. First and later parities presented similar thresholds but responded differently to increase in THI, with NR45 being significantly lower and more susceptible to increases of THI in cows in their first parity than in later parities (0.008 vs. 0.005 decrease per unit THI). Threshold for sensitivity to heat stress changed with the states, with FL, GA, TN having thresholds of 66, 70 and 70 respectively. The decrease in NR45 per unit increase of THI was 0.006, 0.005 and 0.007 for FL, GA and TN respectively (or a total of 0.07, 0.07 and 0.10). On the TN data only, the final fixed effect model used was $NR45 = \text{Herd}(\text{Year}) + \text{Month}(\text{Year}) + \text{age}(\text{parity}) + \text{days in milk} + 100\text{d milk} + \text{THI} + \text{error}$. Animals with more than 150 DIM had a 0.16 lower NR45 than animals with less than 60 days in milk at insemination. Lower milk producing animals showed 0.08 higher NR45 than higher producing animals. A difference of 0.10 in NR45 was observed between THI lower than 70 and THI 84. This variation in NR45 due to THI changes is sufficient to merit further studies to examine genetic components for heat tolerance for this trait.

Key Words: Heat Stress, Non-return rate, Holstein

1016 Analysing survival score and calving interval as a measure of fertility in Holstein Friesian cows in seasonal calving herds. V.E. Olori*¹, T.H.E. Meuwissen², and R.F. Veerkamp², ¹*Irish Cattle Breeding Federation, Bandon, Co. Cork, Ireland*, ²*Institute for Animal Science and Health, ID-Lelystad, Lelystad, The Netherlands*.

In a grass-based production system with seasonal calving, fertility is of major economic importance especially as a delay in conception can lead to culling and a shift in calving pattern. Calving interval (CI) information is readily available from milk records, analysing it presents a problem however as it can only be derived for cows that conceive and calve again. Therefore, calving interval should be treated as a censored trait, with survival to the next lactation (SU) being the censoring variable. These two traits are analysed in this study with a multivariate model to account for the non-random scoring of the CI. Genetic parameters and breeding values (EBVs) for CI and SU were estimated with a sire model for 1st lactation Holstein Friesian cows in Ireland. SU was pre-adjusted for milk yield within HYS. Milk yield was included as a third trait in the analysis because of the large effect it has on both CI and SU. The residual covariance could not be estimated because CI was only known for cows with a SU score of 1 thus this covariance was assumed to be 0. The h^2 was 0.04 for CI and 0.01 for SU with a genetic correlation of -0.28. Genetic standard deviation was 4% for SU and 7 days for CI. EBVs for about 1000 bulls with at least 20 daughters, ranged between -3.28% and 4.22% for survival rate and between -8 and 15 days for CI indicating a difference of about 8% and 23 days between the best and worst bulls. Inter-quartile range was 1.4% and 3.3 days for SU and CI respectively. The current model is expected to recover most of the genetic variation in fertility that can be recovered from calving dates, and future extensions, i.e. use of linear type trait or additional lactations for survival, appear straightforward. These traits now form part of the national index for selecting dairy cows and bulls in Ireland.

Key Words: Cow Fertility, Calving Interval, Survival rate

1017 Correlations among body condition score change, body condition score, production and reproductive performance. C. D. Dechow*¹, G. W. Rogers¹, and J. S. Clay², ¹*Pennsylvania State University*, ²*Dairy Records Management Systems*.

The objectives of this study were to estimate correlations among body condition score change (BCSCH), body condition score (BCS), production and reproductive performance. Producer-recorded BCS were obtained from Dairy Records Management Systems in Raleigh, NC through the PCDART program. Body condition scores were available at both calving (C) and postpartum (PP) for 7,424 cows in first lactation and 6,092 cows in second lactation. An additional 13,196 cows in first lactation and 10,053 cows in second lactation had BCS at C or PP only. Body condition score change was defined as BCS at C minus BCS at PP. Mature equivalents (ME) for milk, fat and protein, days to first service (DFS) and services per conception (SPC) were available. Heritabilities and correlations were estimated assuming bi-variate animal models using Average Information REML. Models included herd-year-season, age at calving, prior calving interval and random animal effect. Non-productive traits were analyzed with and without ME milk as a covariable. Initial correlations between BCS and BCSCH were obtained using all available observations. Additional estimates were obtained through pedigree linkages only by not allowing cows with BCSCH information to contribute BCS observations. Heritabilities estimates for BCSCH ranged from 0.02 to 0.07. Genetic correlation estimates between BCSCH and BCS at C ranged from -0.11 to -0.48. Genetic correlation estimates between BCSCH and BCS at PP ranged from -0.56 to -0.99. Phenotypic correlations between BCSCH and BCS were near 0.54 at C and -0.65 at PP. Genetic correlations between BCSCH and production traits ranged from 0.17 to 0.50. Genetic correlations between BCSCH and DFS ranged from 0.29 to 0.68. Selection for yield appears to increase BCS loss in early lactation by reducing BCS PP. More loss in BCS was correlated with an increase in DFS.

Key Words: Body Condition Score Change, Heritability

1018 Calving disorders of Holstein cows selected for large versus small body size. B.J. Heins*, L.B. Hansen, A.J. Seykora, and G.D. Marx, *University of Minnesota, St. Paul*.

Holsteins selected for large versus small body size since 1966 were evaluated for edema, retained placenta, dystocia, and stillbirths from the Northwest Outreach and Research Center, Crookston, of the University of Minnesota. Edema scores (1 as none to 5 as severe), placental scores (1 as cleaned normally to 5 as prolapsed), dystocia scores (1 as no assistance to 5 as pulled), and stillbirths (0 for alive or 1 for dead) were recorded for 1228 Holstein cows from 1985 to 2000 (born from 1983 to 1999). Records were for 542 first lactations, 320 second lactations, and 366 third or later lactations, and the three lactation groupings were analyzed separately. Investigated were effects of body size line, year of calving, body weight within line, age, sex of calf, and time of calving on the dependent variables: edema score, placenta score, dystocia score, and stillbirths. The large versus small size lines did not differ significantly for edema, retained placenta, or dystocia. However, there was a tendency for edema to increase with body weight within size line. Mean scores were 2.5 for edema, 1.3 for placenta, and 2.2 for dystocia. For dystocia, only sex of calf was significant ($P < .001$) for all lactation groupings. For first calving, the least squares mean for calf sex was 3.4 for males and 2.8 for females. Mean score for dystocia for the entire herd (both body size lines) tended to run higher than the national average and this might have resulted in higher stillbirth rates of calves. The correlation of dystocia and stillbirths was .32 and was highest for first calving. The unadjusted mean for stillbirth rate across all parities and both body size lines (14% for the large line and 10% for the small line) was 12%. The greatest incidence of stillbirths was for first-lactation cows at 23%. Incidence of stillbirth was 3% for second parity and 6% for third and higher parities. For first calving, the body size lines differed significantly ($P < .05$) for stillbirths, with least squares means of 29% for the large line and 22% for the small line. There was no significant trend with time for any of the four traits across the 16 years.

Key Words: body size, dystocia, stillbirths

1019 Genetic parameters for stillbirth in Dutch Black-and-White dairy cattle. A. Harbers*, L. Segeren, and G. De Jong, *CR Delta, Arnhem, The Netherlands*.

Data on stillbirth are recorded in the Netherlands but are not used for a genetic evaluation. Aim of this study was to estimate genetic parameters for stillbirth as a prerequisite for a genetic evaluation. Data included 1 million records of first parity (PAR 1) and 2.8 million records of higher parity (PAR ≥ 2) cows from 1994 onwards. Four different traits (first vs. higher parities and stillbirth as a direct vs. indirect effect) were considered. Heritabilities were estimated using a model with age at calving, parity, year of birth, month of birth, and herd by 2-year period as fixed effects. Random effects were included for sire (direct effect) or maternal grandsire (maternal effect) and residual. Breeding values for indirect effects were computed as maternal effect - 0.5 × direct effect. Genetic correlations were derived from breeding values of bulls adjusted for reliability. Unadjusted means are higher for first parities than for higher (11.4% vs. 5.3%). No phenotypic trend in stillbirth over time was found. Heritabilities range from 0.01 to 0.05. Stillbirth in PAR 1 has only a moderate correlation with stillbirth in PAR ≥ 2 (0.52-0.73), especially for the direct effect. The correlation between direct and indirect effects are -0.07 and -0.02 for PAR 1 and PAR ≥ 2 , respectively. Predicted transmitting abilities (PTA) of bulls range from -7% to +7% for both direct and indirect effects in PAR 1. In PAR ≥ 2 , PTA's range from -3% to +3% for direct and indirect effects. The results indicate that genetic variability for stillbirth exists, but heritabilities are low. Genetic correlations indicate that stillbirth in PAR 1 differ from stillbirth in PAR ≥ 2 . Genetic correlations between direct and indirect effect indicate that both traits can be improved independently. Based on these results a routine genetic evaluation of stillbirth in the Netherlands will be implemented in 2001.

Key Words: Stillbirth, Genetic parameters, Dairy cattle

1020 Timeliness of progeny testing through artificial insemination and percentage of bulls returned to service. H.D. Norman*¹, R.L. Powell¹, J.R. Wright¹, and C.G. Sattler², ¹Agricultural Research Service, USDA, Beltsville, MD, ²National Association of Animal Breeders, Columbia, MO.

Progeny-test (PT) programs of US artificial-insemination (AI) organizations were examined to determine timeliness, PT daughter distribution, and future use of PT bulls. Means, standard deviations (SD), and deciles for bull age at semen distribution, PT daughter birth, and PT daughter calving were calculated by breed (Ayrshire, Brown Swiss, Guernsey, Holstein, and Jersey) for bulls entering AI service since 1959. Mean Holstein bull age at semen distribution (16 mo) changed little over time, but SD decreased from 4 mo in the 1960s to 2.4 mo in the 1990s. Most bulls (80%) had semen released by 18 mo. Mean Holstein bull age at PT daughter birth and calving declined by 4 mo from the 1960s to the 1990s to 29 mo and 56 mo; SD decreased from 6 to 3 mo. Usually for other breeds, bulls were older at PT daughter birth and calving, and SD were larger. Mean Holstein bull age when 80% of PT daughters had been born declined from 36 mo in the 1960s to 31 mo in the early 1990s; for other breeds, bulls were older (36 to 41 mo). Mean Holstein bull age when 80% of PT daughters had calved declined from 65 mo in the 1960s to 59 mo in the 1990s; for other breeds, bulls were older (62 to 70 mo). Percentage of first-lactation Holstein cows that were PT daughters increased over time to 14%. For Holsteins, percentage of herds with five first-lactation records or more that were usable for evaluation but with no usable PT records decreased from 85% in 1965 to 39% in 1998, whereas percentages increased from 11 to 38% for herds with from 1 to 19% PT records and from 1 to 5% for herds with >50% PT records. Percentage of Holstein PT bulls returned to AI service declined from >50% for bulls with PT entry in 1965 to about 15% for bulls with PT entry around 1990; for other breeds, about 20% of recent bulls returned to service. More rapid sampling and increased selection intensity of PT programs have lead to more rapid genetic progress.

Key Words: Artificial insemination, Progeny test

1021 Adjustment for heterogeneity of genetic variance across herds in the Italian Holstein Friesian. F. Canavesi*¹, M. del P. Schneider¹, M. Cassandro², A. Bagnato³, and A. B. Samore¹, ¹ANAFI, Italy, ²University of Padova, Italy, ³University of Milan, Italy.

Heterogeneity of genetic and residual variances exists across herds in the Italian Holstein Friesian population. Residual standard deviations varied from 30 to 35 kg for protein yield and genetic standard deviations across classes varied from 20 to 24 kg. Consequently, heterogeneity of heritability (.30-.34) was observed. The official procedure for genetic evaluation in Italy pre-adjusts for phenotypic within herd variability. This procedure standardizes the residual variance but not the genetic, leaving unchanged the difference in heritability across herds and leading to possible bias in genetic evaluations if daughters of bulls are not randomly distributed across herds. Two methods to account for heterogeneity were tested: a multiple trait approach and a pre-adjustment that takes into account increase of heritability according to herd variability. Methods were compared in terms of sire rankings with the official genetic evaluation. Data used were from the February 1999 official evaluation. The multiple trait approach classified herds into categories of variability and lactations from different categories were considered as different traits. The genetic pre-adjustment of data followed the approach currently applied in the US for its official genetic evaluation. Heritability was assumed to increase with increased within herd variability. Both methods led to a greater representation of bulls in the top list from herds with lower genetic variability (+2/3 bulls) and the difference in kg of protein decreased by 1 kg on average. The multiple trait approach produced a less accurate comparison between generations of bulls, by overestimating older bulls. This result had also an impact on international comparison. Pre-adjustment of genetic variance heterogeneity across herds is now being considered to improve the quality of genetic evaluation procedures in Italy.

Key Words: Heterogeneity of variance, Genetic evaluation, Italian Holstein

1022 Simultaneous accounting for heterogeneity of (co)variance components in genetic evaluation of type traits. N. Gengler^{1,2}, G. R. Wiggans*³, J. R. Wright³, and T. Druet^{1,2}, ¹Gembloux Agricultural University, Gembloux, ²and National Fund for Scientific Research, Brussels, Belgium, ³Agricultural Research Service, USDA, Beltsville, MD.

The multi-trait canonical transformation genetic evaluation system for type traits was modified to estimate adjustments for heterogeneous variance (HV) simultaneously with estimated breeding values (EBV) for final score and linear traits. Heterogeneity, estimated for transformed traits, was regressed within parity toward population mean by fitting a model with fixed effects of mean final score for herd, size of contemporary group, appraisal month, and year-season and a random effect for interaction between herd and appraisal date. Method R was used to estimate variances for the heterogeneity model within each EBV iteration. For 2497 bulls that had been used for artificial insemination, correlations between HV-adjusted and February 2001 official evaluations ranged from 0.981 for suspensory ligament to 0.996 for dairy form. Annual trend for bull EBV was lower with HV adjustment than for official evaluations for all traits except teat length (0.073 points less for dairy form to 0.020 points more for teat length) with the largest percentage reduction (26.4%) for front teat placement. Mean absolute values of differences between HV-adjusted and official evaluations and standard deviations (SD) of those differences generally increased as reliabilities increased to about 80% but decreased slightly for reliabilities of >90%. Mean differences were largest for bulls born from 1985 through 1994 and bulls with daughters with lowest mean final scores. Mendelian sampling (evaluation minus mean of parent evaluations) was calculated for cows born from 1984 through 1998. Mendelian-sampling SD with HV analysis declined less over time than for official evaluations. For regression of SD on birth year, slope from the HV analysis ranged from 21% of slope for official evaluations for rear udder height to 76% for rump angle. Type evaluations of Ayrshires, Brown Swiss, Guerneys, Jerseys, and Milking Shorthorns will be adjusted for HV to enable more accurate selection decisions.

Key Words: heterogeneous variance adjustment, type evaluation

1023 Evaluation of classifiers that score type traits and body condition score using common sires. R. F. Veerkamp¹, C. L. M. Gerritsen¹, E. P. C. Koenen², A. Hamoen², and G. De Jong*², ¹Institute of Animal Science and Health, ID-Lelystad, The Netherlands, ²NRS, Arnhem, The Netherlands.

Subjective visual assessment of animals by classifiers is undertaken for several different traits in farm livestock, e.g. linear type classification, body condition score, or carcass conformation. One of the difficulties is the effect of an individual classifier. To ensure that classifiers rank animals consistently, i.e. the repeatability between classifiers and within classifier, training sessions are required. In this study genetic links across routinely scored records are used to validate scoring of individual classifiers. Absence of a unity correlation between classifiers might be due to poor repeatability between classifiers. Eighteen classifiers of the NRS scored 18 traits, and body condition for 91,589 first lactation heifers, daughters of 601 sires. Genetic correlation of each individual classifiers with all other classifiers grouped where estimated in a series of bivariate analysis. Likelihoods were compared between two models with the genetic correlation either estimated or fixed at unity. Classifiers that scored a large number of animals (ca. 7,500) had a relative large part of the genetic correlation significantly different from unity as these were estimated with large precision. Estimates from classifiers that scored a few animals (ca. 1000) were sometimes low due to sampling. Therefore, a genetic correlation ≤ 0.90 that was significantly different from unity was used as criteria to mark traits for individual classifiers. On average each classifier had 3.3 traits marked, ranging from 0 to 9. Overall feet and legs, rump width, central ligament, and foot angle received most marks (12 to 6 classifiers), but there was agreement (i.e. no mark) for body condition score, stature, rump angle, teat length, overall udder, and teat placement. It is concluded that these simply and cheaply to obtain marks can be used in training sessions to improve the quality of the scoring system.

Key Words: Genetic correlations, Body condition score, Type classification

1024 Evaluations for final score at different ages. L. Klei^{*1}, S. Tsuruta², I. Misztal², and T. J. Lawlor¹, ¹Holstein Association USA, Inc., Brattleboro, VT, ²University of Georgia, Athens, GA.

The objective of this study was to investigate genetic evaluations for final score (PTAT) at different ages. Breeding values were predicted with a random regression model (RRM) and with the current national genetic evaluation model (NE), a repeatability model. RRM included fixed effects for management group and stage of lactation; fixed regressions on age at classification; additive genetic and permanent environmental effects with random regressions on age; and random residual effects. Correlations between PTATs from RRM at various ages and NE ranged from 0.89 to 0.99. PTAT genetic trends for sires and registered cows from RRM at 24 and 60 months of age were similar to those obtained from NE. Trend for grade cows from RRM was lower at 60 month of age than NE trend. The correlation between PTAT of sires and the average age of daughters tended to be positive indicating that daughters of high type bulls are scored more often. Bulls whose genetic evaluation improves as the age of daughters increases tend to have higher genetic evaluations for traits associated with increased longevity. For example, sires with the largest positive difference between PTAT at 60 and 24 months of age had an udder composite evaluation that was 2.7 points higher than those with the largest negative difference in PTAT at the two ages. Proportion of registered cows in the data set decreased from over 80% for cows born in 1981 to 55% for cows born in 1997. Registered cows have mostly two or more scores while grade cows tend to have only a single score at an early age. Declining numbers of scores at later ages may result in selection of sires whose daughters are superior at an early age but age poorly. Evaluation for final score by the random regression model allows identifying bulls whose daughters are superior at an early age and mature gracefully.

Key Words: Holstein, Final Score, Random Regression

1025 Genetic correlations of pathogen-specific clinical mastitis with milk yield and somatic cell score. Y. de Haas^{*1}, H.W. Barkema², and R.F. Veerkamp¹, ¹Institute for Animal Science and Health, ID-Lelystad, The Netherlands, ²Animal Health Service, Drachten, The Netherlands.

Several pathogens play a crucial role in the type of clinical mastitis (CM), and since the etiology of each mastitis-causing pathogen is different the question can be raised whether selection for yields affects all pathogens equally, and if selection for lower somatic cell counts improves resistance to all pathogens equally. Therefore, the objective of this study was to quantify genetic variation for overall and pathogen-specific CM and to estimate genetic correlations with milk yield and somatic cell score. Data from 274 Dutch herds recording clinical mastitis over an 18-months period were used. Analyzed pathogens were *Staphylococcus aureus*, coagulase negative staphylococci, *Escherichia coli*, *Streptococcus dysgalactiae*, *Streptococcus uberis* and other streptococci. The data set contained 47,563 lactations of 28,695 cows of different parities. Cases of overall and pathogen-specific CM were treated as binary traits

in AS-REML. In total, 5,950 lactations with at least one case of CM were included, and in 5,780 cases the mastitis-causing pathogen was classified. Variance components for the sire, maternal grandsire, and permanent environmental effect were estimated using generalized linear mixed models with a logit-link function. Heritabilities ranged from 0.02 to 0.10 for pathogen-specific CM. Genetic correlations of overall CM with milk yield and somatic cell score at 150 days were 0.69 and 0.63, respectively. However, these genetic correlations differed per mastitis-causing pathogen. For instance, the incidence rate of clinical *E. coli* mastitis was slightly unfavorably correlated with 150d milk yield (0.13), but stronger with 150d SCS (0.74). Whereas the genetic correlations with clinical *Str. dysgalactiae* mastitis were 0.70 and 0.16, respectively. Therefore, current selection practices (using milk yield and somatic cell count) will have different effects on the incidence rates of each pathogen.

Key Words: Genetic correlations, Clinical mastitis, Pathogens

1026 Genetic evaluation of episodes of short and long duration of elevated somatic cell scores. X. Li, M. M. Schutz^{*}, A. P. Schinckel, and D. L. Lofgren, Purdue University.

Long or short episodes of elevated somatic cell scores (SCS) may indicate different causes of mastitis and may be under different levels of genetic control. The objectives of this study were to estimate genetic and phenotypic parameters of short and long episodes of elevated SCS, and to compare preliminary Predicted Transmitting Abilities (PTA) of sires for lactation means of SCS and short and long episodes. Two random subsets of Holstein Dairy Herd Improvement Association test-day records represented 70,369 lactations of 51,433 cows and 79,890 lactations of 57,357 cows, respectively. Occurrence of short and long episodes of elevated SCS within a lactation were binomial traits defined by two methods. Method 1 defined short episodes (S1) as test-day SCS increasing by 2 or more units to above 5 and then declining by 2 or more units to below 5 on consecutive test days. Long episodes (L1) were defined when no decrease of 2 occurred for the subsequent test day. Method 2 defined short (S2) and long episodes (L2) similarly, but used the within-herd residual standard deviation of a lactation curve for 30 stage of lactation classes in place of the constant threshold of 5. Genetic components of variation for lactation means of SCS and the incidence of short and long episodes were analyzed using single- and multiple-trait animal models. Heritabilities of lactation SCS (LSCS) and adjusted lactation SCS after removing episodes of short duration (ALSCS) were around 0.10. Heritability estimates were near 0 for S1 and S2, and near 0.04 for L1 and L2. Genetic correlation of LSCS with S1 and S2 averaged 0.902 and 0.945, respectively. Phenotypic correlations were low, about 0.197 and 0.239 for S1 and S2, respectively. Current selection for decreased SCS appears to be consistent with genetic improvement for lower incidence of short episodes of elevated SCS. Low heritability of short episodes may preclude genetic progress from direct selection. The PTA for LSCS and ALSCS were similar giving further evidence that episodes of short duration may be under little genetic control.

Key Words: Mastitis, Somatic Cell Scores, Genetics

ASAS/ADSA Physiology: Estrous Synchronization

1027 Use of ECP in a presynchronized timed artificial insemination protocol for lactating dairy cows. E. R. Jordan^{*1}, S. M. Pancarci², M. J. Schouten³, and W. W. Thatcher², ¹Texas A and M University, ²University of Florida, ³Schouten Dairy, Hico, TX.

To test whether ECP could replace the final GnRH in a timed artificial insemination (TAI) protocol, lactating dairy cows were grouped by week of calving and assigned to treatments on alternating weeks. All cows were presynchronized using two PGF_{2α} (Lutalyse[®]; Pharmacia Corp., Kalamazoo, MI; 25 mg, im) treatments 14d apart (35±3 and 49±3d postpartum). Cows in both groups received a treatment of GnRH (Cystorelin[®]; Merial Ltd., Iselin, NJ; 100µg, im) on d0 (63±3d postpartum). Seven days later (70±3d postpartum) PGF_{2α} was administered. Cows assigned to TAI (n=157) received a second GnRH at experimental d9 (72±3d postpartum) and were artificially inseminated 24 hr later (73±3d postpartum). Cows in the ECPsynch group (n=164) received ECP (ECP[®]; Pharmacia Corp., Kalamazoo, MI; 1 mg, im) on experimental d8 (71±3d postpartum) and were artificially inseminated 48 hr later (73±3d postpartum). Pregnancy was verified 37-44d after insemination

by rectal palpation. Health records of cows were recorded and included in the data analysis. Stage of the estrous cycle at initiation of the treatment protocol and prior cyclicity was determined based on previous observed estrus. Statistical analyses included stepwise logistic regression analysis to determine significant variables and the general linear model of SAS. The treatment by estrus interaction was significant (P<.01). The pregnancy rate for the cows in estrus was 32.8±8.2% (n=28) for TAI and 40.4±4.1% (n=107) for ECPsynch, but 26.8±3.8% (n=129) and 6.6±5.7% (n=57), respectively for cows not observed in estrus. Fewer cows on TAI than ECPsynch expressed visual signs of estrus (P<.01). The pregnancy rate for cows initiating the synchronized regime between d5 and 12 of the estrous cycle was higher than for cows at other stages of the cycle or at an unknown stage (P<.02). Based on these results, pregnancy rates at first synchronized insemination after the voluntary waiting period will be similar for cows receiving either ECP or GnRH as the ovulatory hormone for timed insemination.

Key Words: Timed artificial insemination, ECP, ECPsynch

1028 Presynchronization of estrous cycles in lactating dairy cows with Ovsynch + CIDR and resynchronization of repeat estrus using the CIDR. S.Z. El-Zarkouny*, J.A. Cartmill, A.M. Richardson, M.A. Medina-Britos, B.A. Hensley, and J.S. Stevenson, *Kansas State University, Manhattan.*

Our objectives were to determine if presynchronized estrous cycles and the addition of progesterone (P4) to the Ovsynch (OVS) protocol would improve pregnancy rates (PR) on d 29 and whether a repeat estrus could be resynchronized with P4 after timed AI (TAI). A total of 630 cows in two cooperating herds were assigned to eight treatments (A, B, C, D, E, F, G, and H). All cows received the OVS protocol: 100 µg of GnRH on d -10 and d -1; 25 mg of PGF_{2α} on d -7; and TAI on d 0. Estrus in cows was presynchronized with two injections of PGF_{2α} 14 d apart (Presynch; A, B, C, and D) with the second injection given 12 d before the OVS protocol, whereas cows in E, F, G, and H received no PGF_{2α} before OVS. Cows in C, D, G, and H received (d -7) a P4-releasing intravaginal insert (CIDR) for 7 d (d -10 to -3). Repeat estrus in cows was resynchronized (Resynch; B, D, F, and H) with a used CIDR for 7 d starting on d 13 after TAI, whereas cows in A, C, E, and G were controls. Blood samples were collected before each hormonal injection for determination of P4 (d -36, -22, -10, -3, -1, +13, and +20). On d 29 and 57, PR was diagnosed by ultrasonography after TAI and embryo survival (ES) was calculated. A three-way interaction occurred (P=0.07), indicating that Presynch increased PR (46 vs. 37%), but without Presynch, the CIDR + Resynch reduced and no CIDR + Resynch increased PR. Because of a Presynch × CIDR interaction (P<0.05), AI submission rate for 2nd AI (AISR; first eligible estrus 20-25 d after TAI) was greater (P<0.05) for Presynch cows treated with vs. without the CIDR (38 vs. 18%), whereas in no Presynch cows, the CIDR had no effect (23 vs. 27%). Resynch decreased (P=0.08) 2nd CR (first eligible estrus 20-25 d after TAI) compared to controls (18 vs. 33%). An interaction (P=0.07) of Presynch × CIDR decreased 2nd CR for Presynch cows with vs. without CIDR (15 vs. 29%), but increased 2nd CR for no Presynch cows with vs. without CIDR (38 vs. 20%). We concluded that Presynch + OVS increased PR above OVS alone. Resynch did not increase AISR, decreased 2nd CR, and tended to increase ES.

Trait	Pre-								Re-		
	A	B	C	D	E	F	G	H	synch	CIDR	synch
Cows, no.	81	79	78	80	89	69	82	72	-	P values	-
PR, %	49	47	42	47	37	51	35	27	0.05	0.05	0.56
AISR, %	14	21	37	39	21	26	24	29	0.46	0.01	0.29
2 nd CR, %	34	24	25	5	29	10	44	31	0.44	0.80	0.08
ES, %	60	59	43	60	49	61	55	68	0.68	0.94	0.12

Key Words: Ovulation synchronization, Progesterone, Dairy cows

1029 Characteristics of estrus before and after insemination and fertility after estrus synchronization with GnRH, PGF_{2α}, and progesterone in dairy heifers. A.M. Richardson*, B.A. Hensley, and J.S. Stevenson, *Kansas State University, Manhattan.*

Our objectives were to determine whether estrus activity was diminished after AI and possible pregnancy initiation compared to before AI and whether conception was reduced when a progestin treatment was used without turning over the dominant follicle at the time of progestin initiation. Pubertal Holstein heifers were assigned randomly to three treatments: 1) 100 µg of GnRH given 6 d before 25 mg of PGF_{2α} (d -1) plus a used intravaginal progesterone-releasing (CIDR-B, InterAg) insert (d -7 to 0; CIDR+GnRH); 2) same as CIDR+GnRH without GnRH (CIDR); and 3) same as CIDR+GnRH without used CIDR (GnRH). All heifers were fitted with HeatWatch® patches and characteristics of estrus examined before and after AI included duration of estrus (DUR), number of standing events (STD), and total duration of standing events (DURSTD). Heifers were inseminated 10-12 h after the onset of estrus. Blood samples were collected on d -7, -1, and 0 for determination of progesterone. Pregnancy was diagnosed by ultrasonography 28-30 d after AI. Estrus-detection rates (EDR) and pregnancy rates (PR) tended (P<0.10) to be less for heifers treated with GnRH. Heifers in their luteal phase (d 5-18; n=102) on d -7 had greater (P<0.05) EDR (86 vs. 59%) and greater (P<0.05) PR (50 vs. 29%) than heifers in their follicular phase (d 19-21; n=17). Luteal-phase heifers had shorter (P<0.05) DUR (11.5 ± 0.5 vs. 14 ± 1 h), fewer (P<0.05) STD (34 ± 3 vs. 51 ± 6), and shorter (P<0.05) DURSTD (89 ± 9 vs. 137 ± 17 s) than those in

metestrus (d 1-4; n=35). Heifers (59/69; 87%) not conceiving after the synchronized estrus were detected in estrus 18 to 26 d later. Comparing characteristics of estrus before and after the synchronized estrus in these 59 heifers, STD (36 ± 3 vs. 23 ± 3) and DURSTD (94 ± 7 vs. 60 ± 7 s) were greater (P<0.01) before than after AI, whereas DUR (11.8 ± 0.6 vs. 10.6 ± 0.6 h) and individual DURSTD (2.6 ± 0.1 vs. 2.7 ± 0.1 s) were not different. Conception at this first eligible repeat estrus was 46% (27/59). We concluded that conception rates were not reduced after estrus synchronization with CIDR + PGF_{2α} and estrus activity (STD and DURSTD) was reduced after once inseminated.

Trait	CIDR+GnRH	CIDR	GnRH
Heifers, no.	67	66	68
EDR, %	78.5	87.7	76.7
CR, %	60.4	65.9	55.3
PR, %	44.2	57.4	40.6
PGF _{2α} to estrus, h	68 ± 4 ^a	67 ± 5 ^a	45 ± 4 ^b
% in estrus (49-72 h)	78 ^c	67 ^c	44 ^d

^{a,b}P<0.01. ^{c,d}P<0.05.

Key Words: Estrus, Conception, Progesterin

1030 Time of ovulation and follicular development in estrus synchronized Brahman females. S.R. Tatman¹, D.A. Neuendorff^{*1}, A.W. Lewis¹, T.W. Wilson¹, C.R. Looney², and R.D. Randel¹, ¹Texas A&M Research Center, Overton, TX, ²Ovagenix, LP, Bryan, TX.

Dry, multiparous, Brahman cows were used to determine the effect of PG (25 mg Lutalyse®, Upjohn) injection or an intravaginal progesterone releasing device (CIDR) combined with PG on follicular development from estrus to ovulation and ovulation time. Based on 2 mo of daily estrus detection, cows with normal estrus cycles were selected for the trial. Three treatments (control [CO], PG, CIDR + PG (CP), n=12 per treatment) were used. PG cows received PG on d 14 of an induced cycle. CIDRs were inserted in CP cows and removed after 7 d when PG was injected. Estrus was detected using 4 sterile bulls and constant estrus detection. The dominant follicle was measured by ultrasonography at 2-hr intervals from estrus to ovulation. Follicle size at estrus did not differ among treatments (CO: 17.3±1 mm; PG: 16.6±.9 mm; CP: 18.2±1 mm). Follicle diameter at ovulation was similar (P > 0.10) in CP (18.8±.9 mm) and CO (18.3±.7 mm), but both were greater (P < 0.05) than PG (16.2±.7 mm). No differences were detected (P > 0.10) for change in follicle diameter or change in follicular size/hr from estrus to ovulation (CP: .59±1.3 mm and .019±.04 mm/hr; CO: .94±1.1 mm and .04±.04 mm/hr; and PG: -.43±1 mm and -.011±.03 mm/hr; respectively). Interval from estrus to ovulation was similar (P > 0.10) for CP (27.7±2 hr), CO (27.1±2 hr), and PG (27.4±2 hr). Neither interval from PG injection to ovulation nor PG injection to estrus was different (P > 0.10) between CP (101±9 hr, 74±10 hr; respectively) and PG (118±7 hr, 92±7 hr; respectively). Follicle sizes at CIDR insertion and removal were similar (P > 0.10) in synchronized vs. non-synchronized cows. A lower proportion of CP cows (50%) showed normal estrus compared to PG (83%). In this protocol, the CIDR may have been detrimental for estrus synchronization of Brahman cows.

Key Words: Brahman female, Synchronization, Ovulation

1031 Ovulation synchronization using progestins, GnRH, and PGF_{2α} before timed AI (TAI) and resetting follicular waves for resynchronization of repeat inseminations of suckled beef cattle. M.A. Medina-Britos^{*1}, A.M. Richardson¹, G.C. Lamb², C.R. Dahlen², S.K. Johnson¹, S.Z. El-Zarkouny¹, B.A. Hensley¹, and J.S. Stevenson¹, ¹Kansas State University, ²University of Minnesota.

We determined if there was an advantage to providing progestin before or concurrent with ovulation synchronization prior to TAI. Secondly, we determined whether resynchronization of follicular waves would synchronize repeat estrus after TAI and increase return rates to estrus and 23-d pregnancy rates (23-d PR). Suckled beef cows (n=609) were used at four locations in KS and MN. Cows were assigned to a 2 × 3 factorial experiment with five treatments. Two prebreeding treatments: 1) CIDR: 100 µg of GnRH on d -9 and a progesterone (P4)-releasing intravaginal insert (CIDR, InterAg) for 7 d; 25 mg of PGF_{2α} on d -2;

100 µg of GnRH and TAI on d 0 and 2) MGA: same protocol without CIDR but cows were fed 0.5 mg of MGA for 14 d beginning 26 d before the first GnRH injection. Three postbreeding treatments were: 1) control; 2) 1 mg of estradiol benzoate (EB) + CIDR; or 3) 1 mg of estradiol cypionate (ECP) + CIDR. Estrogen injections were given on d 13 and 20 and a used CIDR was inserted between d 13 and 20 after TAI. Upon removal of CIDR, cows were reseeded after twice daily detection of estrus until d 23. Blood samples were collected on d -35, -21, -9, -2, 0, +13, and +20 for later measurement of P4 and cycling status. Body condition was assessed on d -2. Pregnancy was diagnosed by ultrasonography at 28-33 and 56-61 d after TAI. Variables were calculated: pregnancy rate after TAI (PR); % returned to estrus 20-23 d after TAI (% RET); average interval to estrus after TAI (INT); conception rate after second AI (CR); and embryo survival (ES) from d 28-33 to 56-61. We concluded that a concurrent source of P4 with ovulation synchronization increased PR compared to using MGA. Use of estrogen + CIDR increased return rate to estrus without affecting conception at the previous TAI and increased the 23-d PR.

Trait	MGA	CIDR	Control	EB	ECP
Cows, no.	315	294	307	154	148
PR, %	45.7 ^a	55.1 ^b	52.4	44.1	50.6
RET, %	48.0	50.0	27.4 ^a	73.3 ^b	63.1 ^b
INT, d	21.0±0.1	21.1±0.2	21.0±0.2 ^{a,b}	20.8±0.1 ^a	21.4±0.1 ^b
CR, %	60.0 ^a	47.9 ^b	56.5	46.9	63.0
23-d					
PR, %	58.0	63.3	55.8 ^c	61.7	68.9
ES, %	88.1	90.4	84.6	92.0	96.4

^{a,b}P<0.05. ^cControl vs. EB+ECP (P<0.05).

Key Words: Ovulation synchronization, Progestin, Estrogen

1032 Addition of GnRH to a melengestrol acetate (MGA)-prostaglandin F_{2α} (PG) estrus synchronization protocol in postpartum beef cows. D. J. Patterson*, J. F. Bader, K. K. Graham, F. N. Kojima, G. A. Perry, M. S. Kerley, and M. F. Smith, *University of Missouri, Columbia, MO.*

This experiment was conducted to determine whether addition of GnRH to a MGA-PG protocol would improve synchrony of estrus and maintain high fertility in postpartum beef cows. Primi- and multiparous crossbred cows were assigned by age, body condition score (BCS) and days postpartum (dpp) to one of two treatments. Cows were fed MGA (.5mg·hd⁻¹·d⁻¹) for 14 d followed by an injection of PG (25 mg Lutalyse) 19 d after MGA withdrawal. GnRH (100 µg Cystorelin) was administered to 103 of the cows 12 d after MGA withdrawal and 7 d before PG. Control cows (n=106) received only MGA-PG. Average BCS and dpp for GnRH-treated and control cows were 5.0 and 5.0; 44 and 46 d, respectively. Blood samples were collected from all cows 10 d before and on the first day of MGA, and 7 d before and on the day PG was administered. Progesterone in serum was elevated (> 1 ng/ml) in 40 % of GnRH-treated and 33 % of control cows prior to treatment, respectively (P > .1). Cows were observed for signs of behavioral estrus for 7 d after PG and AI was performed 12 h after observed estrus. Estrus response did not differ (P > .1) between treatments (GnRH: 83 %, 86/103; control: 80 %, 85/106). The mean interval to estrus after PG was 72.0 and 74.7 h for GnRH-treated and control cows, respectively (P > .1). The peak synchronized period for both treatments occurred between 72 and 96 h after PG and did not differ (P > .1) between treatments. Estrus response after PG ranged from 36 to 132 h for GnRH-treated, and from 36 to 120 h for control cows. Synchronized conception (SCR) and pregnancy rate (SPR) did not differ (P > .1) between treatments [SCR: 78 % (67/86), 85 % (72/85); SPR: 65 % (67/103), 68 % (72/106) for GnRH-treated and control cows, respectively]. This study demonstrates similarities in response to a 14-19 d MGA-PG estrus synchronization protocol in postpartum beef cows with or without the addition of GnRH. (Supported by grants from Select Sires, Inc., and USDA-NRI 2000-02163)

Key Words: Estrus synchronization, Progestin, Beef cows

1033 Comparison of melengestrol acetate (MGA)-based estrus synchronization protocols in yearling beef heifers. F. N. Kojima*, J. F. Bader, J. E. Stegner, B. E. Salfen, S. L. Wood, M. F. Smith, and D. J. Patterson, *University of Missouri, Columbia, MO.*

The objective of this study was to identify estrus synchronization protocols that offer potential for use in fixed-time AI programs for replacement beef heifers. Three MGA-based protocols were compared in yearling Angus heifers (n = 345: n = 115/treatment). Heifers were assigned to one of three treatments by reproductive tract score (RTS) and BW 2 wk prior to the initiation of treatments. Treatments were: 1) MGA (.5mg·hd⁻¹·d⁻¹) for 14 d followed by prostaglandin F_{2α} (PG; 25 mg Lutalyse[®]) 19 d after MGA withdrawal (MGA-PG); 2) addition of GnRH (100 µg Cystorelin[®]) on d 26 of the MGA-PG protocol (MGA-GnRH-PG); and 3) MGA for 7 d, PG on the last day of MGA, GnRH 4 d after PG, and a second injection of PG 11 d after the last day of MGA (7-11 Synch). Heifers were monitored for signs of behavioral estrus for 7 d beginning on the day PG was administered. AI was performed 12 h after onset of estrus. Estrus response (ER), synchronized conception rate (SCR), and synchronized pregnancy rate (SPR) were analyzed by Chi-square analysis. Synchrony of estrus was analyzed by ratio of variance (F-test) for mean time interval to onset of estrus. ER did not differ (P > .10) among treatments. Estrus synchrony was greater (P < .05) for 7-11 Synch treated heifers (331.9) than for MGA-PG (667.1) or MGA-GnRH-PG treated heifers (539.3). SCR and SPR were greater (P < .05) for MGA-PG (63 % and 54 %) than MGA-GnRH-PG (45 % and 39 %) or 7-11 Synch (47 % and 37 %) treated heifers. There was an effect of reproductive maturity/cycling status of heifers, indicated by RTS, on ER, SCR, and SPR regardless of treatment. ER (93 % and 81 %), SCR (66 % and 46 %), and SPR (62 % and 37 %) were all greater (P < .01) in cycling compared to non-cycling heifers. Reproductive maturity/cycling status significantly influenced response to synchronization treatment and subsequent conception and pregnancy rate in yearling beef heifers. (Supported by USDA-NRI grant 2000-02163)

Key Words: Estrus synchronization, Artificial insemination, Yearling beef heifers

1034 Effects of a progestin on ovulation, accessory CL formation and follicular development during GnRH and PGF_{2α} treatment in beef cattle. M.L. Mussard*, C.R. Burke, D.E. Grum, and M.L. Day, *Ohio State University, Columbus, OH/USA.*

The improvements in pregnancy rates expected to result from addition of a progestin during a GnRH-PGF_{2α} synchrony system have not been consistently realized in recent field studies. The objectives of this experiment were to determine the effects of a progestin on follicular dynamics and accessory CL formation following treatment with GnRH-PGF_{2α}. Randomly cycling, postpartum beef cows (n=67) received 100 g GnRH on d 0 and 25 mg PGF_{2α} on d 7. Daily transrectal ultrasonography was used to monitor ovarian structures from d -4 to 12. Cows received either melengestrol acetate (.5 mg/hd) daily from d 0 to 6 (MGA; n=33) or the grain carrier for MGA (non-MGA; n=34). Blood samples were collected on d -2, 0, 4, 6, 7, and 9 for progesterone analysis. On d 9, a second injection of GnRH (100 g) was administered to approximately 50% of the animals in the MGA (n=15) and non-MGA (n=16) treatments. Animals that did not receive the second GnRH injection were observed for estrus every 8 h from d 5 to 12. The incidence of ovulation in response to GnRH on d 0, accessory CL formation, diameter of the dominant ovarian follicle on d 7 and 9, and time of ovulation following PGF_{2α} were compared. On d 7, animals in the MGA treatment tended (P < 0.10) to have dominant follicles of greater diameter (12.7 ± .40 mm) and fewer accessory CL (36%) than in the non-MGA treatment (11.8 ± .35 mm and 59%, respectively). Regardless of whether a second GnRH injection was given on d 9, the interval to ovulation following PGF_{2α} was later (P < 0.05) in the MGA than non-MGA treatment (4.2 ± .17 d vs. 3.7 ± .15 d, respectively). In conclusion, treatment with MGA tended to decrease the incidence of accessory CL formation following GnRH, disrupt follicular growth and delay timing of ovulation following PGF_{2α}. Results from this study suggest that inclusion of MGA in a GnRH-PGF_{2α} based synchrony system may alter typical ovarian responses observed in cyclic cows.

Key Words: Beef cattle, Progestin, Follicle

1035 Estradiol Enhances Synchrony and Fertility to Artificial Insemination (AI) or Embryo Transfer (ET) in Brangus Females. J.A. Meyer^{*1}, C.R. Looney², C.R. Long², J.A. Thompson¹, M.L. Day³, H.D. Hafs⁴, and D.W. Forrest¹, ¹Texas A&M University, College Station, TX, ²Ovagenix, Bryan, TX, ³The Ohio State University, Columbus, OH, ⁴Rutgers University, New Brunswick, NJ.

Two trials were conducted to quantify effects of estradiol benzoate (EB) administration on fertility after removal of a controlled internal drug release (CIDR)[®] insert. Lactating, primi- and multiparous Brangus females were administered a CIDR (1.38g Progesterone) for 7 or 8 d with prostaglandin F_{2α} (25 mg, im) administered upon removal of the CIDR (control group). Females allotted to the treatment group were administered estradiol benzoate (EB, 1 mg,im) at 24 h post-CIDR removal. Females were observed twice daily for signs of estrus behavior for 5 d after CIDR removal. In Trial 1, females were inseminated 12 h post-onset of estrus. The synchrony rate (SR; 93.9%) in EB treated (n = 82)

females was higher (P < 0.01) than the SR (80.0%) in the control group (n = 230). First service conception rate (FSCR) was not affected (P > 0.1) by EB treatment (50.6 and 46.4% for treatment and control groups, respectively). However, females in the treatment group had a higher (P = 0.08) first service pregnancy rate (FSPR) than females in the control group (47.6 vs. 36.7%, respectively). In Trial 2, recipient cows received a single embryo 6.5 to 7.5 d post-onset of estrus. SR was higher (P < 0.01) in EB treated (n = 886) females compared to control (n = 457) females (93.0 and 73.5%, respectively). FSCR did not differ (P > 0.1) between control and treatment groups (54.4 and 55.7%, respectively). FSPR was higher (P < 0.01) in EB females (46.1%) compared to females in the control group (38.1%). In conclusion, the addition of an injection of 1 mg EB administered 24 h after a conventional CIDR synchronization treatment regimen increased both SR and FSPR following either AI or ET, in Brangus females.

Key Words: Progesterone, Estradiol, Synchronization

ASAS/ADSA Production, Management, and Environment: Waste Management for Beef and Swine; Reproductive Practices and Measures

1036 Decreasing nitrogen losses from open-dirt feedlot pens by manipulation of organic matter excretion. G. E. Erickson^{*}, T. J. Klopfenstein, and C. T. Milton, ¹University of Nebraska-Lincoln.

Three experiments with yearling steers (404 ± 15 kg) evaluated adding either 15 (15bran) or 30% (30bran) corn bran to a 15% corn silage, corn based diet (0bran). Experiments were conducted from October to February (128 d), February to June (105 d), and June to September (110 d) in eastern Nebraska. Performance and mass-balance of nitrogen were assessed for each pen (8 steers/pen; 4 pens/treatment) in each experiment. No experiment by treatment interactions were detected (P > .10), so performance data were pooled. Increasing dietary corn bran from 0 to 30% increased (P < .01) DM intake and decreased (P < .05) ADG, leading to depressed (P < .01) feed efficiency. Compared to the 0bran diet, feed efficiency was depressed by 7.8 and 10.4% for 15bran and 30bran, respectively, suggesting that organic matter (OM) excretion was increased. For the winter/spring months, increasing dietary corn bran increased manure N and decreased N losses (primarily volatilization) expressed as either kg/steer or percentage of N excretion. During the summer experiment, increasing dietary corn bran did not significantly influence either manure N or N losses. Increasing OM excretion of feedlot cattle may increase manure N thereby decreasing volatilization losses but will also depress feed efficiency.

Item	0bran	15bran	30bran	SE	Linear	Quadratic
ADG, kg/d	1.82	1.81	1.74	.03	.05	.58
ADG/DM intake	.154	.142	.138	.002	.01	.09
Winter/spring, kg/steer						
N manure	12.6	21.1	25.0	1.6	.01	.29
N losses	36.9	31.6	29.3	1.8	.02	.51
%N lost ^a	74.5	59.9	53.9	3.2	.01	.32
Summer, kg/steer						
N manure	6.5	6.2	7.1	1.3	.76	.70
N losses	16.0	17.3	16.6	1.5	.78	.60
%N lost ^a	70.9	73.6	69.6	5.9	.88	.66

^aPercentage of N excreted.

Key Words: Nitrogen, Nutrient management, Manure

1037 Validation of the nitrogen balance in a whole system feedlot model. H. Fairweather, K. A. Beauchemin, and K. M. Koenig, *Agriculture and Agri-Food Canada, Research Centre, Lethbridge, AB, Canada.*

FeedNuts is a stochastic daily time step simulation of a feedlot system model and predicts the nutrient flow (N, P) from feed inputs to the manure and effluent storage systems. Inputs (CP, P, UIP, DM and TDN, % dietary DM) into the FeedNuts model are stochastic and the mass balance is calculated initially for a single animal, which is then aggregated

to the whole system. Data from Bierman et al. (1999; J. Anim. Sci. 77:1295-1305), which evaluated the N balance in a feedlot, were used to verify the model calculations and validate the N balance predicted by the FeedNuts model. The N balance experiments consisted of a digestibility trial and a feedlot trial (87 d) in which cattle were fed one of three corn grain based diets. The diets were: wet corn gluten feed (WCGF, 41.5% of DM), 10% forage (10F) and all concentrate (CONC). Total tract N digestibility of the diets was 65.2, 74.7 and 76.9% for the WCGF, 10F and CONC diets, respectively. The FeedNuts model predicts the total N excreted as the difference between N intake and N retained (calculated using the net protein gain equation, NRC (1996)). A rumen sub-model that accounts for microbial protein synthesis and the degradability of feed protein sources is used to determine N output in urine and feces. Using a daily time step to predict N retention predicted a higher amount of N retained (approximately 0.5 kg over the 87 d) compared with the estimated retention in the feedlot study. However, that calculation used only the final weight. The N digestibility and predicted fecal and urinary N, as a percentage of N intake, were within 10% of the measured values for each diet. Furthermore the predicted relative ranking of diets in terms of fecal and urinary N agreed with the observed. This verification and validation exercise demonstrates the capability of the FeedNuts model for predicting the N balance in the feedlot system at any point in time as a function of ration inputs.

Key Words: Nitrogen balance, System model, Validation and verification

1038 Digestibility of several known dietary manipulations used in combination to reduce nutrient excretion in pigs. S.L. Hankins^{*}, D.C. Kendall, B.E. Hill, and B.T. Richert, *Purdue University, West Lafayette, IN.*

Twelve crossbred barrows (Initial BW=96kg) were blocked by weight and randomly assigned to one of three diets. All diets were formulated to provide 0.48% digestible Lys and were: 1) Standard 13.1% CP corn-soy diet, 0.23% available P (0.50% total P) (STD), 2) 11.5% CP corn-soy diet, 0.15% Lys-HCl, 0.26% available P (0.50% total P) (RCP), and 3) 8.25% CP diet with 5% soybean hulls, high-available P corn, 0.05% phytase and reduced mineral sulfates, 0.40% Lys-HCl, 0.16% available P (0.26% total P) (HRP) to evaluate the effect of several known dietary manipulations in combination on nutrient excretion compared to standard diets. Pigs were adapted to metabolism stalls and dietary treatments for 7 d followed by a 3 d total feces and urine collection. Feces and acidified urine were collected twice daily and frozen until analysis. Pigs were fed at 3X maintenance levels (NRC, 1988) with ad-libitum access to water. Feces and urine were analyzed for DM, nitrogen (N), ammonium N (AMM) and total P (TP). DM digestibility was 88.8%, 88.3% and 87.9% for the STD, RCP and HRP diets, respectively. N and P digestibility were 82.8%, 81.4%, 75.2% and 45.9%, 48.3%, 56.1% for the STD, RCP and HRP diets, respectively. Urine N was 41% and 66% lower (P<.05) from pigs fed the RCP and HRP diets, respectively, compared to the STD diet. Total N excretion was reduced (P<.05) 37% and 55% when the RCP (20.3 g/d) and HRP (14.6 g/d) diets were fed respectively when compared to the STD (32.2 g/d) diet. N retention as a percent of total N absorbed was 30% higher (P<.05) for pigs on

the HRP diet and 16% higher for pigs fed the RCP diet compared to the STD diet. Pigs fed the HRP diet had 55% and 62% lower ($P < .05$) total P excretion (4.0 g/d) than pigs fed the RCP (8.8 g/d) and STD (10.7 g/d) diets, respectively. P retention as a percent of that absorbed tended to be higher for pigs fed the HRP diet compared to the STD diet. Nitrogen and P excretion can be effectively reduced when a combination of synthetic amino acids, high-available P corn, phytase and 5% soybean hulls are fed to finishing pigs.

Key Words: Pigs, Digestibility, Excretion

1039 Effects of soybean hulls in a commercial diet on pig performance, manure composition, and selected air quality parameters in swine facilities. S.A. DeCamp¹, B.E. Hill¹, S.L. Hankins¹, D.C. Kendall¹, B.T. Richert¹, A.L. Sutton¹, D.T. Kelly¹, M.L. Cobb¹, D.W. Bundy², and W.J. Powers², ¹Purdue University, Lafayette, IN, ²Iowa State University, Ames, IA.

Grow-finish pigs ($n=150$) were used to evaluate the inclusion of soybean hulls in swine diets to reduce aerial pollutants and alter manure composition. The pigs (initial BW=85.3 kg) were placed in two identical, environmentally controlled rooms (5 pigs/pen, 5 pens/room; 50 pigs/rep) with 3 replications and treatments rotating between rooms. Diets were split-sex fed and consisted of either a corn-soybean meal based control (C) or the control diet with the addition of 10% soybean hulls and 3.4% supplemental fat (SH) (all diets=3370 Kcal ME/kg; barrows 12.0% CP, 0.53% dLys; gilts 12.7% CP, 0.57% dLys). Pigs and feeders were weighed at 0, 3, and 6 wks to calculate ADG, ADFI, and G:F. Aerial ammonia concentration (AAC), hydrogen sulfide (HS), detection threshold (DT) of odor samples, and pit manure samples were taken at wk 0, 3, and 6. Pigs fed SH diets had greater overall ADG (905 vs 859 g/d; $P < .03$) and tended to have higher G:F (0.326 vs 0.310; $P < .09$) with no difference in ADFI. Pigs fed SH had greater adjusted backfat (113 kg BW) at wk 6 (15.8 vs 14.7 mm; $P < .001$) than C pigs. At wk 6, there was a 20% reduction in AAC ($P < .02$), a 32% reduction in HS ($P < .003$) and an 11% reduction in DT when pigs were fed SH diets. There was a decrease in wk 6 manure pH (7.12 vs 7.26; $P < .03$) and an increase in all individual manure VFA concentrations, with total manure VFA concentrations increasing by 32% ($P < .001$) when pigs were fed SH. At wk 6, the stored manure from pigs fed SH diets had 21% greater total nitrogen accumulation (22.5 vs 18.6 kg; $P < .02$) and an 8% increase in ammonium N accumulation (18.3 vs 16.9 kg; $P < .05$), with no difference in phosphorus. The addition of 10% SH to a commercial type diet can enhance environmental stewardship, without hindering pig growth performance and carcass characteristics. The addition of SH lowered AAC and HS in room air and increased manure N content, indicating greater retention of N in the manure and less N volatilization. This increased manure N reflects a more stable microbial protein form and provides a reduced environmental runoff potential.

Key Words: pigs, odor, manure composition

1040 Effects of dietary phytase and aluminum chloride manure amendments on phosphorus in swine manure. D.R. Smith^{*1}, P.A. Moore, Jr.², C.V. Maxwell¹, and T.C. Daniel¹, ¹University of Arkansas, Fayetteville, ²USDA-ARS, Fayetteville.

Phosphorus (P) runoff from animal manure applied to pastures has been implicated in eutrophication of lakes and rivers. Two technologies that have been proposed to reduce P in manure are the addition of dietary phytase, which allows lower total P to be fed, or addition of aluminum compounds to the manure, which precipitates soluble P. The objectives of this study were (1) to evaluate the effects of dietary phytase, and aluminum chloride ($AlCl_3$) added to swine (*Sus scrofa domestica*) manure, on P in manure and runoff, and (2) to study the effects of $AlCl_3$ amended manure on ammonia volatilization from swine manure. A 2 X 4 factorial design was applied to twenty-four pens of nursery pigs, using two levels of phytase (500 IU phytase kg^{-1} and no phytase), and four levels of $AlCl_3$ (0, 0.25, 0.50 and 0.75% of final manure volume). Each pen was fitted with an individual manure collection pit. A pull/plug manure management system was simulated by flushing pits bi-weekly and recharging with simulated lagoon water, at which time $AlCl_3$ amendments were made. A three phase diet was used with the control diet based on NRC available P (aP) and phytase diets based on NRC -0.1% aP. Ammonia fluxes were measured in-situ twice weekly. Manure was collected at the end of each phase, and analyzed for total and soluble reactive P (SRP). Manure was also collected and applied to 1.96 X 5.96

m plots cropped to tall fescue (*Festuca arundinacea* Shreb.) at a rate of 150 kg N ha^{-1} for rainfall simulations. A simulated 5 cm hr^{-1} rainfall event was conducted on each plot, and runoff samples collected. Phytase reduced SRP in manure by 15% (89.6 mg P L^{-1} for no phytase and 76 mg P L^{-1} for phytase diet, $P < .01$). A 78% reduction in SRP ($P < .001$) in manure was noted in high $AlCl_3$ (34 mg P L^{-1}) pits compared to controls (154 mg P L^{-1}). Ammonia fluxes were reduced ($P < .001$) by 51% for high $AlCl_3$ treatments compared to controls. These two technologies could be employed by production facilities to reduce risk of P losses from swine manure.

Key Words: Phosphorus, Phytase, Aluminum Chloride

1041 Effects of monensin on microbial activity in in vitro swine manure slurries. M.A. Cotta^{*}, R.L. Zeltwanger, and T.R. Whitehead, USDA/ARS/Natl. Cent. for Agricul. Utilizn. Res..

Storage of swine waste is associated with the microbiological production of a variety of odorous compounds, including ammonia, organic acids and alcohols, and sulfides. These compounds can contribute to health problems for swine facility workers and animals, as well as odors that affect local human populations. Previous research in our laboratories has demonstrated that the primary microbial populations in stored swine waste are low (G+C), Gram-positive anaerobic bacteria. Monensin has been used to alter the bacterial population and metabolic end-products in the rumen of domestic animals for improved animal performance, largely through its effect on Gram-positive bacteria. Therefore, it was decided to test the effects of monensin on stored swine waste slurry. Fecal and manure storage pit slurry were collected from a local swine production facility. Manure slurry was combined with 20%(w/v) feces and mixed under gas. The mixture was aliquoted into glass bottles under gas, stoppered and maintained under anaerobic conditions. Monensin (10 μM) was added to two bottles, and two bottles without monensin were used as controls. Gas production was measured over time, and aliquots were removed for chemical analyses and determination of viable bacterial numbers. Gas production in the monensin samples were greatly reduced within 24 hr (<10% of controls), and this reduction was maintained over a 28 day test period. Methane production was also reduced (<5% of controls). However, no detectable hydrogen was observed in any sample. Volatile fatty acid production was only slightly decreased in the monensin samples, while butyrate production increased 3-fold. These results are quite different from those observed in the rumen. Viable bacterial levels as determined by anaerobic agar plating were consistent between the treatments over the test period. Since a shift in bacterial populations was probably occurring during incubations with monensin, total DNA was isolated from the samples. The DNA will be used to assess changes in bacterial populations by 16S rDNA Amplified Ribosomal DNA Restriction Analysis (ARDRA). The results of this study suggests that addition of antimicrobial compounds may prove useful for reducing gaseous, odorous emissions from swine facilities, although monensin may not be the correct one.

Key Words: Swine, Manure, Monensin

1042 Factors influencing estrus and ovulation in weaned sows as determined by transrectal ultrasound. R. Knox^{*1} and S. Rodriguez-Zas, ¹University of Illinois, Urbana IL.

Characterization of factors influencing estrus and ovulation in sows may facilitate development of procedures for improving reproductive performance. The experiment was conducted in confinement during 1997-1999 using 174 Large White x Landrace sows. After weaning, sows were checked for estrus twice daily. In the first year transrectal ultrasound was performed once daily and in the second year twice daily at estrus, and on every day until ovulation. The effects of lactation length (≤ 16 d, 17-24 d, 25-31 d or ≥ 32 d), parity (1, 2 or ≥ 3), season (winter, spring, summer or fall) and weaning to estrus interval (3 d, 4 d, 5 d, or 6-8 d) and their interactions on estrual and ovulatory responses were studied. There was no effect of frequency of ultrasound on any measures so data across years were pooled. Estrus was influenced by lactation length ($P < .001$), with sows lactating ≤ 16 d (35.2%) less likely to express estrus than sows lactating ≥ 17 d (94%). A parity by season interaction effect was observed ($P < .001$) for estrus with lowest expression in parity 1 sows in fall (73.0%) and winter (86.4%), parity 2 sows in fall (67.2%), and \geq parity 3 sows in summer (84.6%). No explanatory variable had a significant effect on wean to estrus interval (4.4 d) or on follicle size at estrus (8.1 mm). Ovulation hour after onset of estrus was affected by

wean to estrus interval ($P < .01$) with sows returning in 3 d ovulating at 46.2 h, and between 6-8 d at 30.2 h. The percentage of sows ovulating was influenced by lactation length ($P < .001$) and wean to estrus interval ($P < .001$). Sows that lactated ≤ 16 d were less likely to ovulate (78.0%) than those lactating ≥ 17 d ($> 92\%$). Sows that returned to estrus in 3 d were also less likely to ovulate (79.5%) than sows returning ≥ 4 d after weaning ($> 92\%$). A parity by season interaction effect was also observed on ovulation ($P < .001$). The data suggest that parity, lactation length and early return to estrus and parity by season effects are associated with risk of failure to express estrus and ovulate.

Key Words: sows, estrus, ovulation

1043 Use of CowTempTM temperature monitoring system for prediction of calving onset in beef cows. J. N. Nielsen^{*1}, S. S. Donkin¹, K. Vanzant¹, P. A. McAfee², and S. A. Brune², ¹Purdue University, West Lafayette, IN, ²Innotek, Inc., Garrett, IN.

The ability to identify cows that will calve within 24 hours would enhance the herd manager's provision of appropriate peripartum care. Previous studies using surgically implanted temperature monitors identified a drop in body temperature from 48-8 hours prior to calving. This study tested the calving predictive value of the CowTempTM, a telemetric system in development that measures and transmits the temperature within the reticulum on a periodic basis. Nine pregnant multiparous beef cows were orally administered a reticular bolus containing a temperature sensor, microprocessor and transmitter 7-41 days prior to calving. Each bolus was programmed with a unique ID number, which was transmitted with temperature via a receiver to a computer that averaged the temperature over a 24-hour period and graphically displayed the results. A computer program was designed to compare the rolling 24-hour temperature average with the previous 5 days' average. The mean temperature nadir and standard deviation (SD) prior to calving was $-0.69 \pm 0.18^\circ\text{C}$ (reduction from rolling average). The nadir temperature was recorded 3.1 ± 2.4 hours prior to parturition. Using a critical temperature from 1 to 2 standard deviations above the nadir (0.39°C), all cows were identified 9-23 hours prior to calving. At 1 SD above the nadir, one of the 9 cows would have been missed, since her temperature drop was not great enough to trigger the alarm. At 2 SD above the nadir this same cow had multiple false alarms for impending calving. Although this is a small sampling of animals, it demonstrates the value of remotely monitoring temperature within the reticulum to predict calving within a 9-23 hour window.

Key Words: Temperature, Calving, Radiotelemetry

1044 Optimal days in period to detect a change in estrus detection. A. de Vries^{*} and B.J. Conlin, University of Minnesota, St. Paul, Minnesota.

The objective was to determine the optimal number of days in a period (DIP) to detect a change in average estrus detection index (EDI) with a Shewhart control chart. EDI is defined as the number of observed estruses over the number of expected estruses in a period. Shewhart charts are tools in statistical process control and distinguish between true changes and normal variation in EDI. A signal is triggered when EDI value falls outside a control limit. Control limits are based on the desired rate of false alarms and a measure of the standard error in EDI from period to period. Typically, EDI is calculated monthly (DIP = 30 or 31). Long periods imply large sample sizes and therefore EDI has more power ($1 - \beta$) to signal a true change. On the other hand, short periods take less time to complete and may signal larger changes faster. Thus, the DIP should be chosen such that the average time to signal (ATS) given a true change is as short as possible. Assuming that the distribution of EDI can be modeled by a normal distribution, then the optimal DIP can be found by minimizing $\text{DIP} / (1 - \beta) = \text{DIP} / [1 - (\text{Pr}(X < \text{EDI}0 - Z * \sigma / \sqrt{\text{DIP}}) + \text{Pr}(X > \text{EDI}0 + Z * \sigma / \sqrt{\text{DIP}}))]$ where X is the EDI random variable, EDI0 is the average EDI before a change, sigma is the standard deviation of EDI with periods of 1 day. The constant Z depends on the desired average days between false alarms (ATS0) and the change of most interest (EDI1): $Z = \Phi^{-1}(\text{DIP} / \text{ATS}0 / 2) - (\text{EDI}0 - \text{EDI}1) / \sigma * \sqrt{\text{DIP}}$ where $\Phi^{-1}()$ is the inverse of the standard normal distribution. Then $\text{ATS}1 = \text{optimal DIP} / (1 - \beta)$ is the average days to signal after the change to EDI1. For example, assume $\text{ATS}0 = 730$ and $\sigma = 0.25$ for a 1000 cow herd. A change from $\text{EDI}0 = 0.6$ to $\text{EDI}1 = 0.4$ is the fastest

detected with $\text{DIP} = 12$ ($\text{ATS}1 = 18.6$). A period length of $\text{DIP} = 31$ would result in $\text{ATS}1 = 31.2$. Similarly, a 100 cow herd with $\sigma = 0.79$ would have optimal $\text{DIP} = 57$ ($\text{ATS}1 = 102.0$). For $\text{DIP} = 31$, $\text{ATS}1 = 115.8$. The conclusion is that optimal period length decreases with larger herd size, larger change of interest, and higher false alarm rate.

Key Words: Estrus detection, Statistical process control, Sample size

1045 The effect of days open on milk produced per day across sequential lactations. J.D. Ferguson^{*1}, D.T. Galligan¹, G. Atzaro², S. Ventura², and G. Licitra², ¹University of Pennsylvania, ²Consorzio-Ricerca Fileria Lattiero-Caesaria.

The objective of this study was to calculate the effect of days open on milk produced per day across sequential lactations in Holstein-Friesian cows. Records (39,929) were collected from the Ragusa, Italy DHIA organization from 263 herds for the years 1995-1999. Each record included herd ID, cow ID, date of parturition, lactation number, total cumulative milk production, and total days in milk at last test record. Cumulative milk production (CUMMILK) was calculated from monthly test records. Calving interval (CI) was determined by the interval between sequential calvings for each cow. The CI was associated with the next lactation record for that cow, as was previous lactation cumulative milk yield (PREVMILK) and previous total lactation days (PREVDIM). Days open (DOPEN) was calculated as $(\text{CI} - 280)$. Total milk produced (TOTMILK) in sequential lactations was $(\text{CUMMILK} + \text{PREVMILK})$. Total days (TOTDIM) was $(\text{CI} + \text{DIM})$ in the subsequent lactation. Milk produced per day (MPD) was calculated as $\text{TOTMILK} / \text{TOTDIM}$. To index production, the 305 milk yield (M305) was calculated based on production curves for each cow-lactation generated from monthly milk records. Data was edited to exclude extreme PREVDIM and DIM records. Final analysis was on 8331 records. MPD was influenced by M305 of cow, lactation number, month of parturition, and DOPEN. The relationship of MPD to DOPEN was nonlinear and fit the following model $(\text{SE}): \text{MPD} = .00341(.00014) * \text{M}305 * \text{DOPEN}^{-.0383(.0111)} * \exp(\text{DOPEN} * -.00014(.0001))$. Selective culling may have resulted in the nonlinear relationship of MPD and DOPEN.

Key Words: days open, milk produced per day, reproductive efficiency

1046 Conception rates of sequential inseminations after batch-thawing multiple straws of semen: A professional technician case study. M. J. Sprenger¹, J. M. DeJarnette^{*2}, and C. E. Marshall², ¹Paddocks Breeding Service, Warsaw, NY, ²Select Sires, Inc., Plain City, OH.

Although standard recommendations for thawing cryopreserved bovine semen are to thaw no more straws than can be deposited in the female within 10 to 15 minutes and to maintain thermal homeostasis during this interval, recent studies suggest thawing more than two straws at once results in compromised fertility of the third or greater sequential insemination number (SIN). This study evaluated the effects of SIN on conception rates (CR) after batch-thawing of straws by a professional AI technician (PAIT). The study was conducted in western NY from June 1999 through May 2000. As efficiency dictated that multiple straws should be thawed ($n = 2$ to 11), the PAIT recorded herd, cow ID, bull ID, AI date, and SIN. Pregnancy data ($n = 6122$) were obtained by cross-referencing the recorded events with each herd#s ($n = 28$) reproductive database subsequent to pregnancy diagnosis. To increase sample size for statistical analyses, $\text{SIN} \geq 7$ were combined and data from 16 small herds ($n < 80/\text{herd}$) were combined as one. Data were evaluated in logistic regression models that included the main effects of herd ($n=13$), SIN, season, service (first or repeat), and all two-way interactions. The herd by SIN interaction tended ($P = 0.07$) to influence CR. In herd E, CR of SIN 5 was lower ($P < 0.01$; 10%, 11/108) than SIN 1 to 4 or 6 and ≥ 7 (28% for each). In herd M, CR of SIN 6 (0%, 0/11) and ≥ 7 (7%, 1/14) were lower than SIN 1 to 5 (32% for each). SIN had no effect ($P > 0.10$) on CR in the other 11 herds nor across all herds (1 = 32%, 397/1260; 2 = 33%, 411/1250; 3 = 34%, 386/1129; 4 = 33%, 300/917; 5 = 32%, 219/696; 6 = 29%; 133/464; $\geq 7 = 35\%$, 142/406). Additionally, CR evaluated by the total number of straws in each thaw revealed no decline in fertility due to batch-thawing. These

data suggest that PAITs and herdsman inseminators who follow recommended semen handling procedures can thaw more than two straws at once without compromising conception rates.

Key Words: Cryopreserved bovine semen, AI, Batch-thawing

1047 Results of Breeding Soundness Evaluations performed on Senepol bulls in the US Virgin Islands. R.W. Godfrey* and R.E. Dodson, ¹University of the Virgin Islands, Agricultural Experiment Station, St. Croix.

The Breeding Soundness Evaluation (BSE) was used to evaluate Senepol bulls on 3 farms on St. Croix over a 2-yr period. One set of bulls (SELECT; n = 75) was tested prior to sale or use in the breeding herd. The second group of bulls (UNSELECT; n = 440) was tested at 4-mo intervals without any prior selection. Bulls in the SELECT and UNSELECT groups ranged in age from 12.7 to 89.3 mo and 6.5 to 101 mo, respectively. Bulls were given a rating of satisfactory or unsatisfactory based the BSE guidelines. Data were analyzed using GLM and chi-squared procedures of SAS. In the UNSELECT group the percentage of bulls passing the BSE increased (P < .0001) with age. In the SELECT group the percentage of bulls passing the BSE decreased (P < .02) with age. In the UNSELECT group, bulls that passed the BSE had larger SC (P < .0001), greater sperm motility (P < .0001) and a higher percentage of normal sperm (P < .03) than bulls that failed. In the SELECT group, bulls that passed the BSE had a higher percentage of normal sperm (P < .0001) but there was no difference (P > .10) in SC or sperm motility. Of the SELECT bulls that failed the BSE, a higher percentage (P < .0001) received passing scores for sperm motility and SC than they did for sperm morphology (92, 94.4 and 1.1 %, respectively). Of the UNSELECT bulls that failed the BSE, there was no difference (P > .10) in the percentage that received passing scores for SC, sperm motility or morphology (7.2, 7.7 and 9.7 %, respectively). In the SELECT and UNSELECT groups, 28 and 197 bulls were tested more than once, respectively. In the UNSELECT bulls that were tested more than once, there were increases in SC (P < .0001) and sperm motility (P < .01), but not sperm morphology (P > .10) over time. In the SELECT bulls that were tested more than once there was no effect of time on SC, sperm motility or morphology (P > .10). These results indicate that sperm morphology had a greater impact on the proportion of Senepol bulls passing the BSE than did testicular size or sperm motility.

Key Words: Bull, Scrotal Circumference, Semen Quality

1048 Effects of GnRH-PGF based estrus synchronization with or without short-term progestin exposure on reproductive performance of postpartum suckled beef cows. J. M. DeJarnette, R. A. Wallace, and C. E. Marshall, *Select Sires, Inc., Plain City, OH.*

This study evaluated the effects of short-term progestin exposure on synchrony of estrus and reproductive performance of postpartum beef cows synchronized to estrus using GnRH and PGF. Postpartum (80 2.2 d) Angus cows were injected (im) with 100 mg of GnRH on d #7 and PGF (0.5 mg cloprostenol) on d 0. Animals were randomly allotted by parity and calving date to receive either: 1) no further treatment (GP; n = 45) or 2) 0.5 mg/hd/d of melengestrol acetate (MGA) from d #6 through d #1 (GMP; n = 54). Unbalanced sample size is due to herd-owner decision (subsequent to treatment allocation) to bred animals to randomly detected natural heats during the 2 week prior to treatment, however, postpartum interval and parity distribution remained balanced across treatments. Twice daily observation for estrus began on d #3 and continued until 72 h post-PGF. Cows detected in estrus were bred by AI 8 to 12 h later (EAI). Cows not detected in estrus by 72 h post-PGF were fixed-time inseminated and concurrently injected (im) with 100 mg of GnRH (TAI). Cows were exposed to herd bulls on d 13 and ultrasonographic pregnancy diagnosis was performed on d 38. Data were analyzed in logistic regression models that included the effects of treatment, parity, postpartum interval, body condition score, and all two-way interactions. Although fewer (P = 0.08) GMP than GP-treated cows were detected in estrus (59 vs. 76%, respectively), the numerical difference (P = 0.30) in conception rate at TAI (56 vs. 36%, respectively) and the absence of estrus by 24 h post-PGF (0 vs. 9%, respectively) suggests a greater degree of ovulatory synchrony was established by GMP treatment. Conception rates to EAI (GP vs. GMP; 75 vs. 69%) and synchronized AI pregnancy rates (GP vs. GMP; 67 vs. 63%) were not affected (P > 0.10) by treatment. These data suggest

MGA can be used to prevent premature estrus in GnRH-PGF treated cows without compromising AI pregnancy rate.

Key Words: Estrus synchronization, Melengestrol acetate, Progestin

1049 Effectiveness of a stand-alone electronic estrus detection device - MountCount. H. K. Baitis*, J. B. Hall, D. E. Eversole, and D. Cuddy, *Virginia Polytechnic Institute and State University, Blacksburg, Virginia.*

An electronic estrus detection (EED) system, HeatWatch® (DDx, Inc., Boulder, CO), increases estrus detection efficiency in cattle, but requires receivers, repeaters, and a computer. MountCount® (DDx, Inc., Boulder, CO) is a stand-alone EED unit that indicates estrus status by lights. Information on the effectiveness of MountCount® (MC) compared to other estrus detection systems is limited. The objective of this study was to compare the efficiency and accuracy of visual estrus detection (VIS) or MC to HeatWatch® (HW). In trial 1, dry open cows (n=50) were fitted with both MC and HW. Cows were observed for estrus for 10 d and then synchronized with prostaglandin. In trial 2, lactating postpartum cows (n=136) were randomly fitted with either MC or HW. Cattle were synchronized with either 7-11 or CO-Synch protocol. Cattle were observed 2x/d (trial 1; VIS-2) or 5x/d (trial 2; VIS-5) for visual signs of estrus, MC status and condition of MC and HW. In trial 1, either MC or HW detected more (P<.001) cows in estrus than VIS-2. VIS-2 and MC agreed with HW 43.0% and 93.3%, respectively, when HW indicated cows were in estrus. MC more often indicated (P<.02) that cows were in estrus when HW did not indicate estrus. Agreement with HW was 85.0% and 70.0% for VIS-2 and MC, when HW indicated no estrus activity. In trial 2, for HW cows, VIS-5 identified fewer (P<.03) cows in estrus than HW. Estrus detection rates were 86.7% and 100% for VIS-5 and HW, respectively. For MC cows, VIS-5 identified more (P<.02) cows in estrus than MC with estrus detection rates of 96.0% and 78.0% for VIS-5 and MC, respectively. Pregnancy rates to artificial insemination were not different (P>.15) for MC cows (47.8%) compared to HW cows (30.4%). Observers indicated that MC was difficult to visualize in daylight. We conclude that MC is superior to twice-daily visual estrus detection, but appears less effective than intensive visual estrus detection or HW.

Key Words: Estrus Detection, Cows, Electronic

1050 Lowering dietary P in dairy rations reduces the vulnerable P fraction in manure. Z. Dou*¹, K. Knowlton², G. Zhang¹, Z. Wu³, and R. Kohn⁴, ¹University of Pennsylvania, ²Virginia Tech, ³Penn State University, ⁴University of Maryland.

Phosphorus (P) accumulation on livestock farms contributes to elevated P runoff loss and accelerated eutrophication of surface waters. Recent studies strongly suggest that the amount and concentration of P in dairy manure can be substantially reduced by lowering dietary P levels in lactating cow rations while maintaining cow performance. Yet, little is known concerning the effect of dietary manipulation on the forms and relative solubility of manure P. The objective of this study was to characterize P in dairy feces collected from several feeding trials, each comparing two or three dietary P concentrations in lactating dairy cows. Fecal samples, collected during various stages of lactation, dried and ground, were measured for readily soluble P by extracting in deionized water with 1 hr shaking. Selected fecal samples were used to determine P fraction distributions using a sequential extraction procedure. Lowering dietary P levels dramatically reduced the amount of readily soluble P in fecal materials. For example, decreasing dietary P from 0.47% to 0.39% of feed DM resulted in a reduction of readily soluble P from 4.33 to 2.82 g/kg fecal DM. In another trial, decreasing dietary P from 0.52% to 0.34% reduced readily soluble P from 4.40 to 1.82 g/kg DM. The same pattern was observed throughout the sampling periods covering up to 11 wks in lactation. Results from the sequential extractions indicate that dietary P levels not only affected the quantities but also the relative proportions of P fractions in feces. For instance, cumulative P released in repeated water extraction accounted for 88%, 84%, and 76% of the total P extracted through the sequential extractions corresponding to dietary P levels of 0.67%, 0.52%, and 0.34% DM. Reducing excessive P in diets may lead to a substantial decrease in the potential runoff loss of manure P from fields.

Key Words: Dietary P, Manure, P fraction

1051 Reducing phosphorus solubility in animal manures using chemical amendments. J. D. Toth*¹, G. Zhang¹, Z. Dou¹, and J. D. Ferguson¹, ¹*University of Pennsylvania*.

Controlling nutrient losses from animal manures when they are land-applied is a critical factor in nutrient management, promoting environmental health and maintaining the sustainability of animal agriculture. Phosphorus is of particular concern due to its implication in eutrophication of surface waters and declines in water quality. We conducted a laboratory experiment to test the effect of several chemical amendments on reducing P solubility of animal manure. Freshly excreted swine or dairy manure samples were treated with aluminum sulfate (alum) or coal combustion byproducts: fluidized bed combustion flyash (FBC), flue gas desulfurization product (FGD), or anthracite refuse flyash (ANT). After incubation at ambient temperature for 3 d, subsamples were dried and ground. Samples were extracted with shaking for 1 hr in deionized water and the pH and inorganic and total P concentrations measured. Selected samples were extracted using a sequential procedure developed in our laboratory to identify the changes in soluble P forms as a function of amendment type and rate. Compared to untreated controls,

alum, FBC and FGD substantially reduced water soluble inorganic P in the 1 hr extract in fresh swine manure (by 80, 60 and 77%, at 250, 400 and 250 g amendment per kg DM manure, respectively). The 1 hr water extractable inorganic and total P in dairy manure were reduced by an average of 65 (alum at the 50 g rate) and 50% (FBC at the 400 g rate). The ANT amendment was ineffective in reducing water soluble P in swine manure, and both ANT and FGD ineffective in dairy manure. In the sequential, repeated extraction trial, addition of the amendments alum, FBC or FGD to swine manure reduced the total water soluble inorganic P concentration and increased the concentrations of bicarbonate, hydroxide and acid-soluble P by 11-21% compared to the control, demonstrating effectiveness in shifting inorganic P from the most vulnerable, water-soluble fraction to less soluble forms. The alum and FBC amendments had a similar effect on the dairy manure samples. Additional trials are planned to examine the amendments for other manure types and to refine effective rates of addition to reduce soluble P.

Key Words: Phosphorus Solubility, Nutrient Management, Manure Nutrients

Beyond pH: Metabolic Factors Affecting Pork Quality

1052 The Effect of the RN⁻ Allele on Meat Quality and how the Gene was Discovered. K. Lundstrom* and L. Andersson, *Swedish University of Agricultural Sciences, Uppsala, Sweden*.

The RN⁻ allele was first identified in France as causing a reduction in the yield of cured cooked ham from composite lines containing the Hampshire breed. The effect was determined by "Napole yield" (Rendement Napole in France), a standardized method for estimating yield. The dominant allele decreasing the yield was called RN⁻ and was due to an increase in muscle glycogen content. The RN locus has been mapped to chromosome 15, and has recently been identified as a mutation in the PRKAG3 gene, which encodes a muscle-specific isoform of the regulatory λ subunit of adenosine monophosphate-activated protein kinase (AMPK).

The RN⁻ allele has a great effect on technological meat quality, leading to a decrease in ultimate pH and water holding capacity, and an increase in reflectance value. The chemical composition of meat is also altered with an increase of glycogen and water content and a reduction of pro-

tein content. These changes lead to a reduction in the yield of cooked cured ham. On the other hand, the eating quality is enhanced. In several Swedish studies, pork from animals carrying the gene had higher juiciness, meat taste and acidulous taste and usually a higher tenderness. Also Swedish consumers preferred pork from carriers of the RN⁻ allele in comparison with non-carriers. Processed meat from RN⁻ carriers also showed a higher juiciness and tenderness in sensory tests with a trained panel. In contrast, French results showed a negative effect on eating quality. Also, the production traits are altered as an effect of the RN⁻ allele, leading to a higher growth rate and a higher proportion of lean meat in the carcass.

The gene frequency of the RN⁻ allele has been around 0.6 in Swedish Hampshire. Due to the negative effect of the RN⁻ allele on technological meat quality, most countries and breeding companies would like to eliminate the mutation. With the mutation identified, this could be easily achieved. However, the positive effects of the RN⁻ allele on eating quality should be taken into consideration.

Key Words: RN⁻ allele, Meat Quality, Napole Yield

ASAS/ADSA Food Safety and PSA Pathology

1053 Effect of dietary fiber on enterohemorrhagic *Escherichia coli* O157:H7 shedding in lambs. M. Lema* and L. Williams, Alabama A & M University.

E. coli O157:H7 is an emerging food-borne pathogen implicated in several outbreaks. Fecal shedding of the pathogen constitutes the mode of entry into the human food chain. We compared the influence of dietary acid-detergent fiber (ADF) concentration on fecal shedding of the pathogen and meat production efficiency of lambs. Fourteen growing-finishing Suffolk ram lambs averaging 28.13 kg in body weight were arranged in two 7 x 7 Latin squares with 1-week adaptation and 2-weeks of fecal sample collection and fed diets with 5, 10, 15, 20, 25, or 35 % ADF content, ranging from all-concentrate (5 % ADF) to all-forage diet (35 % ADF). Diets were fed daily at the rate of 1.4 kg/head. Fecal samples were collected weekly and analyzed for *E. coli* O157:H7 using modified tryptic soy broth with novobiocin as a pre-enrichment broth and cefixim-tellurite sorbitol MacConkey agar (CT-SMAC) as a selective media. *E. coli* O157:H7 was confirmed by its reaction with O157 and H7 antisera. Lamb growth rate and daily dry matter intake were determined and composite feed samples analyzed for nutrient content. When fed 10, 15, 20, 25, 30 and 35 % ADF in the diet, *E. coli* O157:H7 shedding was comparable among treatments suggesting that within 10 to 35 % ADF range dietary fiber does not impact *E. coli* O157:H7 shedding. However, lamb growth rate and feed efficiency were significantly lower ($P < 0.05$) for the 25, 30 and 35 % ADF diets. The 5 % ADF (100 % concentrate) diet resulted in significantly higher ($P < 0.05$) shedding of the pathogen (6.09 versus 5.12, 4.82, 5.21, 5.05 and 5.04 log₁₀ CFU/g of feces for the 10, 15, 20, 25, 30, and 35 % ADF diets, respectively) than the other treatments. The results suggests that increasing the ADF content of the concentrate ration between 10 and 20 % ADF results in significant reduction in the shedding of *E. coli* O157:H7 as compared to 5, 25, 30, and 35 % ADF diets without adversely affecting animal meat production efficiency.

Key Words: *E. coli* O157:H7, Fecal shedding, Dietary fiber

1054 Simultaneous detection of *Salmonella* sp. and *E. coli* O157:H7 using PCR on beef carcasses from a slaughterhouse in Mexico City. E Lopez, R Alonso, MS Rubio*, F Nuez, M Nicoli, and P Miranda, Facultad de Medicina Veterinaria y Zootecnia, Universidad Nacional Autonoma de Mexico.

The aim of this work was to develop a multiplex PCR assay to detect simultaneously *Salmonella* (S) and *E. coli* O157:H7 (Ec) on beef carcasses. Shiga like toxin I, II, eaeA gene and uidA primers were used to detect Ec. The invA gene was used to detect S. In order to have an internal control to distinguish between negative and false negatives results, we incorporated to the PCR mix pBR322 plasmid DNA and primers specific to amplify a characteristic fragment. PCR reaction conditions, which amplify DNA from both bacteria, and control plasmid, were as follow: a denaturalization step at 94C by 3 min followed by 30 cycles consisting of 94C during 30 s, 50C for 30 s and 72C by 30 s and finally a step of 72C for 3 min. Experimentally infected meat was used to evaluate the assay. Individual strains and the mixture of both (meat was previously washed using a physiological salt solution) were used. Non-infected washed pieces of meat were used as negative controls. The assay was evaluated in field specimens. Sixty beef carcasses from slaughterhouses were sampled on the shoulder region with sterile cotton swap on a delimited surface of 17x17 cm². To transport, the swap was kept in a plastic bag containing a peptone broth. Before DNA extraction, samples were cultivated in an enriched broth and incubated for 24 h. Results indicated that the positive experimental controls (individual strain and mixture) showed the expected amplified bands. Washed meat showed no band. Field results showed that none of the carcasses were contaminated with Ec, and only 10% of the carcasses were positive to S. Standards microbiology procedures of the samples showed a higher percentage of samples with S, which in comparison with the PCR results indicates that no all the S found were invasive.

Key Words: PCR, *E. coli* O157:H7, *Salmonella*, Meat

1055 Simple and Rapid Method for Screening Antimicrobial Activities of *Bifidobacterium* Species of Human Isolates. S.A. Ibrahim* and M.M. Salameh, North Carolina Agricultural and Technical State University.

Bifidobacteria constitute a major part of the human intestinal microflora. Many health benefits are associated with bifidobacteria including their antimicrobial activities. For this reason, there has been increased interest in the development of a rapid method for screening antimicrobial activities of *Bifidobacterium* isolates from human fecal samples. The objective of this research was to develop a rapid procedure for the screening antimicrobial activities of *Bifidobacterium* species of human isolates. A Bifidobacteria selective medium BIM-25 agar was modified by adding of 0.5g/l cysteine-hydrochloride, 1.5g/l lithium Chloride, 1.5g/l beef extract, and 5ml/l Tween 20. This medium was inoculated (45C) with diluted fecal material from 5 subjects and overlaid into 0.1% Tween 20 BHI agar plates. Plates were incubated in anaerobic chamber at 37C for 48 hours. Plates were then inverted to allow the two layers of agar to fall into the petri lid. BHI soft agar (0.45%) containing *Micrococcus luteus* (as indicator) was overlaid onto the other layers in the petri dish. Plates were incubated at 37C overnight and zone of growth inhibition was observed. This method is simple and rapid whereas the original method for screening of antimicrobial activities of bifidobacteria is a more time consuming and cumbersome procedure.

Key Words: Rapid Method, *Bifidobacterium* species

1056 D-value Determination of *Listeria monocytogenes* and *Salmonella typhimurium* in low fat ready-to-eat processed meat. Kevin McCormick*, Inyee Y. Han, and Paul L. Dawson, Clemson University, Clemson, South Carolina/US.

The research was conducted to determine the best processing temperature for inactivating *Listeria monocytogenes* and *Salmonella typhimurium* on packaged turkey bologna. To determine the best treatment temperature, the D-values of *L. monocytogenes* and *S. typhimurium* at various temperatures were tested. A low-fat turkey bologna was cut into 3cm² squares and irradiated to ensure that the sample was sterile before being inoculated. Each sterile sample was inoculated with approximately 10⁸ CFU/ml inoculum and aseptically placed into a LLDPE pouch and vacuum-sealed. Then, the samples were submerged in a water bath held at constant temperature, and removed at timed intervals. Different water bath temperatures between 60° and 85° C were used with processing temperatures measured and recorded using a CALPlex datalogger and Calsoft software. The number of cells on each sample was determined by plating on appropriate growth media after making serial dilutions. The plates were incubated for 48 hours, and the counts were used along with time and temperature data to determine the D-values at 60°C, 65°C, and 70°C. At 85°C water temperature, no *L. monocytogenes* cells were detected (< 10²) after 10 seconds submersion, while at 60°C cells were detected (> 10²) up to 10 minutes after submersion of the packaged meat in the heated water bath. Similar results were found for *S. typhimurium*. The data shows that significant reductions in bacterial counts can be achieved with these temperatures and that only a small increase in temperature greatly affects the D-values for both bacteria examined.

Key Words: D-value, *Listeria monocytogenes*, *Salmonella typhimurium*

1057 Molecular Subtyping and Tracking of *Listeria monocytogenes* in Hispanic Cheese Factories. D.Y. Kabuki¹, A.Y. Kuaye¹, M. Wiedmann², and K.J. Boor², ¹Faculdade de Engenharia de Alimentos-UNICAMP-Brazil, ²Food Safety Laboratory - Department of Food Science-Cornell University.

This research focused on identifying *L. monocytogenes* prevalence patterns to track sources of bacterial contamination in Hispanic-style fresh cheese manufacture, which represents a growing sector of the New York State dairy processing industry. A total of 357 samples were collected from three Hispanic cheese factories in New York City during 4 visits in a 6-month period. *L. monocytogenes* was found in 6.3% (7/111) of finished fresh cheeses and 11.0% (27/246) of environmental samples (food contact surfaces, floor drains, floors, walls and miscellaneous). Among

the environmental samples, 30% of drain and 20.6% of floor samples were positive for *L. monocytogenes*. A total of 80 representative isolates from all positive samples were subtyped for allelic polymorphisms using PCR-RFLP for virulence genes encoding listeriolysin O (*hlyA*) and ActA (*actA*). Allelic type 4 for *actA* and allelic type 1 for *hlyA* (lineage I) were predominant among the isolates. Isolates were classified to lineage I (80.0%) more frequently than to lineage II (20.0%) or III (0.0%). 23 *L. monocytogenes* isolates from the factory with positive cheeses and food contact surfaces were ribotyped using EcoRI with the Qualicon RiboPrinter. Ribotypes DUP-1044 (82.6%), DUP-1045 (13.0%) and DUP-1039 (4.4%) were identified among the isolates tested. A unique *L. monocytogenes* subtype (*actA* type 4, *hlyA* type 1, and ribotype DUP-1044) was isolated from finished products, drains, floors, a plastic connecting tube, and a polytetrafluorethylene table in one plant. This subtype was found during all 4 visits to this plant. Our subtyping data indicate persistent environmental contamination as a primary source of finished product contamination. Although the prevalence of *L. monocytogenes* positive samples decreased following some modifications in the plant's sanitation program during the sampling period, the unique, persistent *L. monocytogenes* strain still remained in the factory. We conclude that focused measures will be required to eliminate persistent *L. monocytogenes*, which are a likely cause of finished product contamination.

Key Words: *Listeria monocytogenes*, cheese, subtyping

1058 Characterization of isolated bacterial strains with antagonistic properties against food-borne pathogen *Listeria monocytogenes*. H. Roman*, E. T. Ryser, S. Rust, and M. T. Yokoyama, *Michigan State University, East Lansing, MI/United States*.

Listeriosis in ruminants is most frequently implicated with improperly fermented silage. The causative agent is *Listeria monocytogenes*. We hypothesize that bacterial strains, antagonistic against this foodborne pathogen, can be isolated directly from the farm environment. Three wild bacteria strains (designated Ba-E, Bs-3 and Bs-13) antagonistic towards strains of this pathogen (CWD246 Brick silage and DGallup CWD95), were isolated from fresh corn silage and rumen fluid. Isolates were identified as *Bacillus* spp. according to the API system, FAME and 16S rRNA. Ammonium sulfate precipitation of these isolates revealed the presence of bioactive protein factors. SDS-PAGE analysis of two of these preparations (Bs-3 and Bs-13) showed that only one peptide band displayed antimicrobial activity. These peptides were sensitive to protease and gastric peptidases (protease, proteinase K, chymotrypsin and lipase) tolerant of changes in heat (30-100C), organic solvents (acetone, acetonitrile, ethyl alcohol, methanol, chloroform and toluene) and pH (4 # 8). We speculate that at least one of these bioactive peptides may be a new bacteriocin which can potentially be used as a probiotic for silage and other feeds to control *Listeria monocytogenes*. These isolates survived and grew in TSB with yeast extract, containing either rumen fluid (50% v/v) or bile (0.3% w/v). An *in vitro* challenge study using co-cultures of *Listeria monocytogenes* CWD246 Brick Silage and strains of *Bacillus* spp (either wild type or ATCC 6633 strains) was conducted. Both the optical density (OD_{600nm}) and the viable counts (log cfu/0.1ml) of *Listeria monocytogenes* were monitored during a 24-h period. The treatment containing a mix of two wild type strains of *Bacillus* spp. (Bs-3 and Bs-13) was more effective in decreasing the viable counts of *Listeria monocytogenes*. We conclude that this combination might be a better treatment for controlling *Listeria monocytogenes* than either the ATCC6633 strain or the Ba-E wild strain. This research was partially supported by the National Food Safety & Toxicology Center, MSU.

Key Words: Listeriosis, Bacteriocin, Probiotic

1059 The effect of environmental and substrate factors on the growth and survival of *Salmonella agona*. S.A. Ibrahim*, T.A. Lloyd, M.M. Salameh, A. Shahbazi, R. Purcell, and C.W. Seo, *North Carolina Agricultural and Technical State University*.

Salmonella agona (*S. agona*) is one of approximately 2000 *Salmonella* serotypes that can cause illness in humans. *S. agona* has been linked to cereal food outbreak. This is the first time a commercial cereal product has been implicated in a *Salmonella* outbreak. *S. agona* is an uncommon serotype of *Salmonella*, it is found in a variety of animal reservoirs including poultry, cattle, pigs, and animal feed. Little information is

available about the physiology, growth and survival of this pathogen in foods. Therefore, the objective of this research was to determine factors affecting the growth and survival of *S. agona* in foods. Two strains obtained from the Center for Disease Control (CDC); *S. agona* H6115 and F 5567 were used in this study. Results indicated that 30C is optimum growth temperature for *S. agona*. Acetic acid is most inhibitory organic acid at pH value of 5.5. The addition of 3% sodium acetate or 3% sodium chloride showed significant reduction (P < 0.05) in microbial growth. Heat treatment at 55C for 20 min, 57.5C for 14 min, or 60C for 5 min was needed to achieve 5-log reduction in microbial populations. Thermal resistant of *S. agona* can be lowered by combining extrinsic factors such as pH, sodium chloride or sodium acetate. Cold shock at 2C for 25 min, prior to heat treatment, increased the thermal sensitivity of *S. agona*. In a model broth system, thermal death time at 57.5C was reduced by up to 1.5 log after the pathogen was cold shocked for 25 min. This indicates that cold shock has a potential to become a practical method to control pathogens in foods.

Key Words: *Salmonella agona*, Thermal

1060 Effects of Tasco® 14 on Prevalence Levels of Enterohemorrhagic *Escherichia coli* and *Salmonella* spp. in Feedlot Steers. A.R. Barham¹, B.L. Barham*¹, J.R. Blanton, Jr.¹, V.G. Allen¹, K.R. Pond¹, and M.F. Miller¹, ¹*Texas Tech University*.

The purpose of the study was to determine the effects of Tasco® 14 supplementation at 2% of a commercial grain based diet on *Salmonella* spp. (SAL) and Enterohemorrhagic *E. coli* (EHEC). Sixteen pens from a large commercial feedlot in West Texas were fed Tasco® 14 supplementation for 14 days starting at day forty-five of the feeding period and received a second supplementation for 14 days prior to shipment to slaughter facilities. Fecal and hide samples were collected from 13 animals in each pen for USDA approved microbiological assays prior to feeding Tasco® 14, prior to shipment for slaughter, and immediately following exsanguination. Prevalence levels were generated using the frequency procedures in SAS (1995). Changes in prevalence levels from the three sample times were analyzed using the T-test procedure in SAS (1995). Prior to Tasco® 14 supplementation, prevalence of EHEC and SAL was 18% and 39% respectively on hides and 34% and 30% in fecal samples. After the 14d feeding period prevalence of EHEC and SAL were 5% and 34% respectively on hides and 0% and 30% in fecal samples. Data reveals that at the packing facility, prevalence of EHEC and SAL were 0% and 70% respectively on hides and 2% and 57% in fecal samples. A significant reduction in EHEC on both hides and fecal samples occurred after the first feeding of Tasco® 14 compared to the pre-feeding samples (P < .05). The first Tasco® 14 supplementation did not significantly reduce SAL on hides but did significantly reduce prevalence of SAL in fecal samples. The second feeding period of Tasco® 14 significantly reduced EHEC in fecal samples when compared to both the pre-feeding and the first Tasco® 14 supplementation sample times. Samples taken at the packing plant indicated significantly lower prevalence levels of EHEC when compared to pre-feeding samples. SAL prevalence was reduced in fecal and hide samples at the packing plant when compared to samples taken after the second supplementation of Tasco® 14.

Key Words: Beef Cattle, *E. coli*, *Salmonella*

1061 A challenge trial testing the effects of Acid Pak 4-Way on *Salmonella* cecal colonization in broiler chicks. J.W. Evans* and M.S. Plunkett, *Alltech Biotechnology, Inc., Nicholasville, KY*.

An experiment was conducted to evaluate the effectiveness of a product containing a combination of organic acids, electrolytes, bacteria and enzymes (Acid-Pak 4-Way, Alltech, Inc.) at reducing cecal colonization in day-old chicks challenged with *Salmonella typhimurium* 29E (1 x 10⁶ CFU/g). Day-old chicks were randomly assigned to a control chamber with an untreated water supply or to a chamber supplied with water containing 1g/L Acid-Pak 4-Way. The experiment consisted of five control groups and five treatment groups with ten chicks in each group. Each chick was inoculated by oral gavage with a standard inoculum to provide similar microflora at the beginning of the experiment. On d3, each chick received 0.25ml *S. typhimurium* (4 x 10⁶/ml) by oral gavage. On d10 chicks were sacrificed and both ceca removed. The content of one cecum was diluted and plated on Brilliant Green Agar (BGA) to determine salmonella concentrations. The content of the other cecum

was placed in deionized water to measure pH levels and to determine VFA concentrations. The cecum was then placed in lactose broth to be used as a confirmation in samples that did not grow on the BGA. Cecal VFA concentrations and pH in the treatment group were not different from those in the control group. However, salmonella concentrations were lower ($P < 0.01$) in the treatment group ($6.87 \log_{10} \text{CFU/g}$) than in the control ($7.5 \log_{10} \text{CFU/g}$). The results from this experiment indicate that adding Acid-Pak 4-Way to the drinking water of young chicks reduces the cecal colonization of chicks exposed to salmonella.

Key Words: Water acidification, Challenge trials, Salmonella

1062 Effect of an essential oil blend on coccidiosis in broiler chicks. J.W. Evans*, M.S. Plunkett, and M.J. Banfield, *Alltech Biotechnology, Inc., Nicholasville, KY.*

The effects of a dietary essential oil blend on an *Eimeria acervulina* and *Clostridium perfringens* infection was investigated in broiler chicks. Two hundred, day-old chicks were housed in ten isolation chambers. At 15d old, one hundred and fifty were allotted to ten isolation chambers with 15 chicks per chamber. Chicks in five chambers received a starter poultry diet as a control. The chicks in the remaining five chambers received the same diet containing an essential oil blend (1.0% clove oil, 0.1% thyme oil, 0.1% peppermint oil, and 0.1% lemon oil). All chicks received 0.25ml *Cl. Perfringens* ($4 \times 10^8 \text{CFU/ml}$) for three days by oral gavage on d19-21. They received 0.25ml oral gavage of 2.5×10^5 *E. acervulina* oocysts on d22. Five chicks per chamber were sacrificed on d15, 22 and 36, and the entire gastrointestinal tract (GIT) was removed for *Cl. perfringens* enumeration. The chicks were housed on raised wire mesh floors in isolation chambers. From d21-35 feces were analyzed for oocysts. Performance parameters were measured on d15, 22, 29 and 36. The control chicks live weight was greater than the live weight of the treatment chicks on d36 (1575 vs. 1429g, $P < 0.05$). Feed intake was lower in the treatment chicks than in the control chicks from d15-21 (80 vs. 75g/bird/d, $P < 0.01$). FCR was not affected by treatment. Fecal oocyst yields were lower in the treatment chicks than in the control chicks at the peak of the infection (d26) (5.24×10^8 vs. 6.86×10^8 oocysts/bird/d, $P = 0.028$). The average of the total oocyst yields were also lower over the whole infection (9.94×10^8 vs. 1.17×10^8 oocysts/bird/d, $P = 0.032$). No differences in GIT *Cl. perfringens* populations were observed between treatments. The results of this trial indicate that the addition of essential oils to a normal poultry diet reduced the oocysts excreted at peak infection, however the addition of the oils also appeared to reduce the overall performance of the birds.

Key Words: Coccidiosis, Essential oils, *Eimeria acervulina*

1063 Apramycin resistance of *E. coli* isolated from cold-stressed swine. D.B. Arnett*, P. Cullen, P.D. Ebner, and A.G. Mathew, *University of Tennessee, Knoxville, TN.*

To determine if the development of resistance to apramycin in *E. coli* isolated from cold-stressed swine could be linked to plasmids, six weaned pigs were administered apramycin in the feed (150 g/ton for 14 d) and was exposed to cold stress in the form of an 8C reduction in recommended daily temperature throughout the wean-to-finish period. Fecal swabs were taken on days 0, 2, 7, 14, 28, 64, 148, and 149 for recovery of *E. coli*, and isolates were tested for sensitivity to apramycin using microdilution minimum inhibitory concentration (MIC) analysis. One resistant and one sensitive isolate were randomly chosen from each sampling day, and plasmids separated from each isolate. Plasmid profiles of resistant and sensitive isolates were compared based on plasmid number and size. Arbitrarily primed PCR (AP PCR) was used to identify resistant plasmids. PCR fingerprints were made of all plasmids using primers 23L and OPB-17. Pulsed-field gel electrophoresis (PFGE) was performed on chromosomal DNA using *SpeI* and *XbaI* restriction endonucleases. Profiles from AP PCR and PFGE were compared separately for similarity by eye and by using a molecular analyst fingerprinting software that created dendrograms for comparisons. Resistant plasmids were not identified, and the source of resistance could not be linked to plasmids by these methods. Other methods, including southern blot analysis, may be needed to identify resistance plasmids.

Key Words: swine, antibiotic resistance, plasmids

1064 The effect of antibiotics on broiler body weight, feed conversion and tibial dyschondroplasia scores. T.L. Peters*, K.D. Roberson, R.M. Fulton, and M.W. Orth, *Michigan State University, East Lansing, MI/USA.*

One of the major metabolic skeletal disorders that effect the long bones of fast growing birds is tibial dyschondroplasia (TD). Disrupted bone metabolism allows an avascular plug of cartilage to accumulate in the metaphyseal region of tibiae, which can weaken bones. The etiology of TD remains unclear. Recently, we found that doxycycline, oxytetracycline, enrofloxacin, ceftiofur, and salinomycin inhibited in vitro cartilage degradation of embryonic chick tibiae. Therefore, the objective of this study was to determine if these five antibiotics inhibited cartilage degradation and induced TD in growing broilers. Day-old male broiler chicks were randomly assigned to a treatment group and placed in a heated wire-floored battery brooder at 8 birds per pen with 3 pens per treatment. Chicks had ad libitum access to feed and water and were raised under continuous fluorescent light. Oxytetracycline, chlortetracycline, doxycycline, salinomycin, enrofloxacin, and ceftiofur were administered appropriately to chicks. A non-antibiotic control and thiram (a fungicide known to induce TD) group were also included in the experiment. Weekly growth rates and feed consumption were measured. Both proximal tibiotarsi were visually inspected for TD lesions at 22 days of age. Oxytetracycline, chlortetracycline, doxycycline, and ceftiofur did not differ from the control for any parameter tested. All salinomycin treated birds were lighter than controls; however, feed conversion only differed at the highest dose and TD incidence was not different for any dose tested. The lowest dose of enrofloxacin treated birds were heavier, but there was no difference for any dose in feed conversion or TD incidence. Control birds had a 15% incidence of TD while the 20 ppm thiram treated birds had a 92% incidence rate. Body weight and feed conversion were not different for thiram treated birds. Therefore, the results of this study show that the antibiotics tested are likely not involved in the etiology of TD in broilers.

Key Words: Tibial dyschondroplasia, Cartilage degradation, Antibiotic

1065 Haematological and histological findings in experimental Newcastle disease. F Galindo¹, N Calderon¹, M Charles¹, G Tellez¹, and T Fortoul², ¹*Departamento de Produccion Animal Aves, FMVZ, UNAM*, ²*Departamento de Biologia Celular y Tisular, Facultad de Medicina, UNAM.*

In an attempt to obtain more information about the pathogenesis of haemorrhages in Newcastle disease, blood cells counts with special emphasis on thrombocytes were performed in 25 specific pathogen-free chickens experimentally infected by ocular instillation of 10^6 embryolethal doses 50% of a velogenic viscerotropic strain of Newcastle disease virus (Chimalhuacan strain); five control chickens were also included. Birds were killed at 24 hours followed by 12 hours intervals. Whole blood and tissue samples were collected. The previous studies were complemented with the histological evaluation of bone marrow, brain, kidney, lung and proventriculus of the same animals. In this study a significant reduction of thrombocyte counts was detected within 72 hours post infection (hpi). A typical lymphopenia was detected; also an increase in heterophils and a decrease in monocytes at 60 hpi was observed. The histological findings consisted in swelling and vacuolization of capillary endothelial cells, mainly in the bone marrow and lung at 60 hpi. In the bone marrow early necrosis of haematopoietic islands was noted within 48 hpi. At 72 hpi there was a multifocal necrosis with the loss of cellular details and abundant debris. The thromboplasts at 60 hpi showed cytoplasmic vacuolation, nuclear vacuolation and basophilia. The thrombocytopenia and the endothelial damage are considered the main causes of haemorrhages. In this study, it is presumed by our findings that thrombocytopenia resulted from a direct mononuclear precursor cell viral damage of the thrombocytes in bone marrow.

Key Words: Newcastle disease, haemorrhages, vascular endothelium, thrombocyte, bone marrow

1066 Pathogenesis of thrombocytopenia in Newcastle disease: ultrastructural study. F Galindo¹, N Calderon*¹, G Tellez¹, and T Fortoul², ¹*Departamento de Produccion Animal Aves, FMVZ, UNAM*, ²*Departamento de Biología Celular y Tissular, Facultad de Medicina, UNAM.*

The ultrastructure of the bone marrow in 25 chickens experimentally infected with the Newcastle disease virus, Chimalhuacan strain and five control chickens were studied in order to determine if the virus caused direct damage to thrombocytes or their precursors. Light microscopy observations of semithin sections in the bone marrow revealed cell depletion and marked cell degeneration, principally of granulocytes and erythrocytes. At 24 hours post infection (hpi) electron microscopy showed cells with dense cytoplasm and chromatin associated with cellular death. At 36 hpi, decreases in erythrocytes and in some granulocytic cells were observed, and spherical electron-dense structures like viral particles were detected in dilated vesicles, as well as dilation of Golgi complex and endoplasmic reticulum. At 48 and 60 hpi an important depletion of hematopoietic cells was found and several cells presented perinuclear edema with necrosis or cytoplasmic degeneration. Apoptotic cells also were observed. At 72 hpi in the hematopoietic islands, few cells were found which showed necrosis and numerous cellular debris. Our results indicate that the depletion and necrosis of hematopoietic cells, including thrombocyte precursors, were responsible for thrombocytopenia detected in the early stage of the disease.

Key Words: Newcastle disease, pathogenesis, thrombocytopenia, thromboplast, electron microscopy, chickens

1067 Organochlorine pesticide residues in cow's milk from tropical region of Veracruz (Mexico). V.T. Pardo*¹, K.N. Waliszewski², and A. Ramirez¹, ¹*Universidad Veracruzana, Veracruz, Veracruz/Mexico*, ²*Instituto Tecnológico de Veracruz, Veracruz, Veracruz/Mexico.*

The purpose of the study was to assess the organochlorine pesticide levels in cow's milk produced in the central agricultural region of Veracruz State. These pesticides are intensively used in Mexico, causing exposure to significant levels of contamination to consumers and livestock. A hundred and twenty milk samples were collected bi-weekly at random during six weeks from farms located in three areas. Samples were cooled down, the fat layer was separated by centrifugation and stored in glass vials at -25°C until analysis. Organochlorine pesticide levels were determined by GLC/ μ ECD according to USEPA Method 608. A recovery study was performed on ten replicate spiked blank milk fat samples. Analyses were conducted for α -, β -, and γ -HCH, pp'-DDT, op'-DDT, pp'-DDD and pp'-DDE. The residue levels were reported as ng/g on lipid basis and the estimated dietary exposure as ng/day. Results were analyzed by analysis of variance with Minitab 10.5. Milk samples from Tlalixcoyan area showed a mean level of γ -HCH 128 ng/g which was significantly higher than Lindane residues in Jamapa (49 ng/g) and Paso San Juan (22 ng/g) milk samples. The mean value of Σ -HCH 230 ng/g was two times the FAO/WHO tolerance level of 100 ng/g. Concerning to DDT, mean levels of op'-DDT 26 ng/g, 39 ng/g of pp'-DDE, and 89 ng/g of pp'-DDT were found in milk samples collected from Jamapa area. The mean value of pp'-DDT was significantly higher than the levels detected in samples collected in the other two areas and four times the FAO/WHO tolerance level of 20 ng/g. For all chlorinated pesticide residues the estimated mean daily intake was 6.9 ng/d. Results indicate direct cattle exposure to HCH and DDT due to the fact that Lindane is still used to a limited extent for animal husbandry and the spray of DDT in vector control programs against malaria in Veracruz. This fact causes special concern since milk plays a central role in human nutrition and these pesticides have provided compelling evidence of hormone disruption activity in humans and lipid profile-disrupting activity in laboratory animals.

Key Words: Organochlorine pesticides, cow's milk, dietary exposure

1068 Detection of ochratoxin A in sorghum grain using various methods. J.H. Franco de la Torre*, W.P. Reyes, R. Nuo, and A. Taylor, *Centro Univ. de Los Altos, Universidad de Guadalajara.*

Ochratoxin A (OA) is a secondary metabolite, produced by *Aspergillus ochraceus* and *Penicillium viridicatum*. It is found as a frequent contaminant in various grains, cereals and animal feeds. The purpose of this

trial was to compare the efficiency of three immunoassay techniques (Veratox, Ridascreen, and Agraquant), and two immunoaffinity techniques (Afinitest and Ochratest), with HPLC in the detection of OA in sorghum grain, artificially and natural contaminated. Also two extraction methods (acetonitrile 60% and methanol 70%) were validated for the OA determinations with HPLC. The OA data were analyzed with a random and an angular transformation for arcsine of the CV for precision, the exactitude with the quadratic error, and the linearity with simple lineal correlation. The results showed that Agraquant gave a high linearity, precision, and exactitude, similar to the HPLC ($P > 0.05$), while Veratox, Ridascreen, Afinitest, and Ochratest; overestimate the detected levels of OA ($P < 0.05$). The extraction methods were similar ($P > 0.05$) in detecting OA, giving an additive constant of recuperation with acetonitrile, while the methanol has given a proportional recuperation (85%) as a multiplicative constant. Therefore, the immunoassay are a choice compare to HPLC in the detection of Ochratoxin A in animal feedstuffs.

Key Words: Ochratoxin A, Immunoassay, Immunoaffinity, HPLC

1069 Interaction between ochratoxin and aluminosilicate on the histopathologic aspect of organs and the humoral immunity against Newcastle disease virus in broilers. Elizabeth Santin*, A.C. Paulillo, A.C., Alessi, E.L. Krabbe, and A. Maiorka, *Faculdade de Ciências Agrárias e Veterinárias - UNESP, Jaboticabal, SP, Brasil.*

This study aimed at evaluating the effect of ochratoxin in the diet, in the presence or absence of aluminosilicate, on the histopathological aspect of the liver and the kidneys and the humoral immune response of broilers vaccinated against Newcastle disease virus (NDV). The exposure of 200 broilers to 2 ppm of ochratoxin, either in the presence or absence of aluminosilicate, reduced their humoral immune response and the number of mitotic cells in the bursa, but aluminosilicate did not influence ($P > 0.05$) these parameters. All groups reacted to antigenic stimulation by NDV at 11 days of age, but the best ($P < 0.05$) hemagglutination-inhibiting antibody titers were obtained in birds not exposed to ochratoxin (GMT 8.04, 8.24, 6.59 and 6.89 to group without ochratoxin and aluminosilicate, group with aluminosilicate, group with ochratoxin, and group with ochratoxin and aluminosilicate, respectively), which demonstrated the interference of this mycotoxin in the humoral immune response of broilers vaccinated against Newcastle disease. The liver of the birds exposed to this toxin showed an increase in its relative weight, and histopathological lesions of vacuolisation, megalocytosis in hepatocytes and proliferation of bile duct cells, whereas the kidneys had hypertrophy of proximal tubule cells and megalocytosis, with thickening of the glomerule membrane. The presence of aluminosilicate did not reduce the deleterious effects promoted by ochratoxin in broilers. Although several prior studies showed the efficacy of aluminosilicates in cases of aflatoxicosis, recent research demonstrated that these minerals do not inactivate other types of mycotoxins. This is probably due to the variation in the structure of adsorbent substances, as the adsorption is a function of ion and/or molecule exchange between these compounds and mycotoxins.

Key Words: Ochratoxin, Aluminosilicate, Immunity

1070 Surveillance programme of the microbiological safety and hygiene of meat in South Africa. AE de Jesus¹, EM Buys*¹, RP Greebe¹, J Kruger¹, L Kgosana¹, and WH Giesicke², ¹*Animal Nutrition and Animal Products Institute, Agricultural Research Council, Irene 0062, South Af.*, ²*Department of Agriculture North West Province, Mmabatho 2735, South Africa.*

The Directorate of Veterinary Services (DVS) of the Department of Agriculture in the North West Province recognised the need for information on the microbiological status of the meat supply as an essential supplement to veterinary efforts of improving hygiene management during the harvesting and post-harvesting stages of the meat supply chain. The Animal Nutrition and Animal Products Institute (ARC-ANPI) was contracted to design and implement a surveillance scheme to monitor the microbiological quality of meat after the final stages of slaughtering and at the retailer. The present project was not just to establish the microbiological quality of meat in the NWP. It was also designed as a model to be used to improve meat quality and safety in the whole of the RSA. From a practical point of view, the "bacterial scores" generated by the MeatStats programme developed show how each abattoir performed while the "abattoir ranking system" shows where abattoirs

stand compared to other abattoirs. A particularly attractive feature of the bacterial score and rating systems is that the scoring is entirely based on sample data and that subjective scoring is eliminated. With such systems and assistance at hand, the present surveillance system can only benefit the whole meat industry for many years to come.

Key Words: Base line study, Microbiological safety, Meat

1071 Fermentation of whey permeate to lactic acid by *Lactobacillus helveticus* in a spiral-sheet bioreactor. M.M. Salameh*, A. Shahbazi, S.A. Ibrahim, M. Mims, and V. Shirley, *North Carolina Agricultural and Technical State University.*

The United States generates nearly 325 billion gallons of wastes and by-products during the processing of foods. Whey is a by-product produced in cheese industry and it is estimated that as much as 40-50% of the whey produced is disposed of as sewage or applied to agricultural lands. The remaining 50-60% is being used primarily for animal feed or for human food. Whey contains high quantity of lactose and other nutrients, which can be easily utilized by lactic acid bacteria to produce organic acids and value added products. The objectives of this work were to determine the ability of spiral-sheet to immobilize *Lactobacillus helveticus* (*L. helveticus*) and to determine the performance membrane for the continuous production of lactic acids using cheese whey as by-product. Active culture of *L. helveticus* (ATCC15009) was weekly transferred into fresh MRS and maintained at 4C. This culture was inoculated into 9 liters of MRS and incubated at 37 C for 16-18 hours. Fermented broth was transferred into the spiral-sheet bioreactor and was allowed to immobilize for 24 hours. After successful immobilization, MRS broth was withdrawn and replaced by fresh 4.8% lactose-MRS broth under aseptic conditions. Bioreactor was connected to Bioflo III (2-liter fermentor which has a control loop for temperature and pH) with continuous medium circulation at 37 C and agitation rate at 100rpm. Samples were withdrawn every 6 hours for lactose and lactic acid analysis using HPLC. Changes in pH were monitored during fermentation process. During fermentation the pH value was dropped from 6.2 to 3.8, which inhibited the bacterial activity. During the following experiments, we adjusted the pH to 6.50 by neutralizing the acid with 5-N ammonium hydroxide. Under the controlled pH condition, lactose conversion rate was 59.00%. These results showed that immobilization of *L. helveticus* on spiral-sheet reactor was a successful operation for the continuous production of lactic acid.

Key Words: spiral-sheet bioreactor, *Lactobacillus helveticus*, immobilization

1072 Molecular certification in chicken meat channel. V. Haezebroeck¹, R. Renaville*¹, I. Parmentier¹, S. Fontaine¹, S. Hetzel¹, and D. Portetelle¹, ¹*Animal and microbial biology Unit, Gembloux Agricultural University, Gembloux, Belgium.*

Adulteration of meat products is prohibited for fair trading, consumer protection, religious reasons or public health. As DNA can be extract from many different sources (blood, raw or cooked meat, milk,), DNA fingerprinting methods find an interesting applicability in species identification and meat traceability. Microsatellites markers are very polymorphic loci constituted by a variable number of a tandemly repeated motif of 1 to 6 base pairs, more commonly (CA)_n/(TG)_n. There are

abundant, multi-allelic, codominant and uniformly distributed throughout the genome of numerous species. The aim of this study was to find specific chicken microsatellites markers and to verify their ability to authenticate chicken products from other major meats. Nine microsatellites markers (MCW180, MCW135, MCW68, LEI161, MCW239, MCW264, LEI162, HUJ2, LEI78) were selected in the chicken genome and were combined in three triplex reactions. No cross-amplification were observed with bovine and pig DNA. All the nine microsatellites were also tested for cross-species amplification with other avian genomes. We observed that the microsatellite LEI161 give amplification product only for chicken. LEI161 is associated in a triplex PCR reaction with the markers MCW239 and MCW264. These three markers were revealed to easily distinguish chicken or turkey meat products. In conclusion, this triplex could be used to authenticate chicken or turkey in food and to detect falsification. Such a mean of analysis give new and alternative approaches of animal and species characterisation in meat products (Grant S-5876, Belgian Ministry of Small Enterprises, Traders and Agriculture DG4 and DG6 / and Belgian Public Health Ministry).

Key Words: Certification, Chicken, Meat

1073 Nutritional evaluation of Bt-corn in pigs . Tim Reuter, Karen Aulrich*, Andreas Berk, and Gerhard Flachowsky, *Institute of Animal Nutrition, Federal Agricultural Research Centre .*

The increasing cultivation of genetically modified plants opens new questions to animal nutritionists. One of them is to compare the nutritional value from parental and transgenic plants, another one is consumer safety. Analytical investigations to check the nutritional value are in progress at our institute, also investigations on the fate of "foreign"-DNA. The present project deals with a balance study to check the substantial equivalence, a grower-finisher trial to measure the pig performances and the fate of foreign-DNA in different tissues of pigs. The pigs were supplied with a 70% corn of the parental or the Bt-line containing diet. In a three collection period containing trial with twelve pigs we compared the feeding value of the Bt and the parental corn. All measured parameters were similar for both corn lines as shown in Table 1 (p > 0.05). The pig performances were measured with 48 pigs in a second trial. 12 pigs were fed a diet containing the parental corn, 36 pigs a diet containing the Bt corn. There were no significant differences (parental vs. Bt) in daily weight gain g/d (81593 vs. 80464), feed consumption kg/d (2.060.10 vs. 2.040.16) and Feed:gain kg/kg (2.550.27 vs. 2.590.18) between both groups (p > 0.05). The calculated results base on a growing period of 91 days. To investigate the fate of foreign DNA pigs were divided into different groups of six pigs each and slaughtered on different times after feeding. Samples were taken after slaughtering from different tissues.

Table 1. Digestibility of crude protein (dP), N-free extracts (dX) and metabolizable energy (ME) of diets

	1.period (grower)		2.period (finisher)		3.period (finisher)	
	control	Bt	control	Bt	control	Bt
dP %	83.33.1	86.21.8	85.62.4	85.02.0	85.71.5	87.01.6
dX %	91.60.8	92.40.7	93.20.4	93.30.5	93.40.5	93.70.6
MJ ME/kg DM	15.40.3	15.70.2	15.80.2	15.60.2	15.90.1	15.90.2

Key Words: Bt-corn, Genetically modified plants, pig

PSA Environment and Management

1074 The Effect of Lighting Program and Light Intensity on the Performance and the Incidence of Leg Abnormalities of Broiler Chickens . A. Kamyab*¹, S. Raja-Abadi², K. Yousefi³, and A. Taghipour Farshi⁴, ¹*University of Tehran, Animal Sci. Dept.*, ²*University of Mazandaran*, ³*Mobark Andish, Co.*, ⁴*Telavang, Co.*

This experiment was conducted in a 2x2x2 factorial arrangement, using two different lighting regimens, continuous (23L:1D) vs. intermittent (1L: 3D), two light intensities, high (30 Lx) vs. low (8 Lx) and two sexes. Some 864-day old chicks were randomly distributed by sex among 24 pens of 36 chicks each. In the first 2 days, all birds received 23 hours of light per day with 20 Lx intensity. After that chicks were subjected to an intermittent or continuous lighting program, combined

with two different intensities. At the end of study, day 42, body weight gain was affected by lighting treatments (P<0.05), but feed intake was not affected by lighting programs and intensities, and the only difference was found among males and females which had reflected the sex effect (P<0.05). Cumulative feed conversion among lighting programs, intensities and genders was significant (P<0.05). Comparison of feed conversions revealed the superiority of the intermittent lighting program relative to continuous one, low intensity compared to that of high intensity and males in comparison with females (P<0.05). The interactions of lighting programXintensity, lighting program x sex and intensity x sex were significant in some cases (P<0.05). Abdominal fat was affected by lighting treatment and was much lower in broilers reared under the intermittent lighting regimen than that of the broilers reared under the continuous one. Also males deposited less fat than that of the fe-

males ($P < 0.05$). Comparison the effects of high and low intensity on abdominal fat showed no discrepancy ($P > 0.05$). The lighting programs, intensities and sexes interactions, in most cases, had a significant effect on abdominal fat ($P < 0.05$). When comparing the effects of treatments on mortality, no significant differences were found. Meanwhile, the difference of bone ash percentage was not statistically significant among the different treatments.

Key Words: Light, Intensity, Leg abnormality

1075 Effect of a subtherapeutic level of virginiamycin on the clearance of *E. coli* O157:H7 from an anaerobic continuous-flow culture of chicken microflora. Toni Poole*, Kenneth Bischoff, Todd Callaway, and David Nisbet, *USDA,ARS, College Station, TX 77845.*

Antibiotics are used in food animal production for growth promotion; these drugs typically target Gram-positive microorganisms. An anaerobic continuous-flow fermentation culture of chicken gastrointestinal microorganisms has been used as a model of the chicken ceca to study interactions between normal avian gut microflora and enteropathogens. Previous studies have shown that such a culture clears *E. coli* O157:H7 at a rate of one log/CFU/day. The purpose of this study was to determine if virginiamycin, an antibiotic used for growth promotion that targets Gram-positive microorganisms and anaerobes, would provide a selective growth advantage for *E. coli* O157:H7; thus preventing clearance from the continuous-flow culture. Two of three identical chicken continuous-flow cultures were treated with 1.0 $\mu\text{g/ml}$ virginiamycin, a concentration considered to be subtherapeutic. After one week of virginiamycin treatment, 1.0×10^7 CFU/ml *E. coli* O157:H7 was added to all three cultures. For the duration of the experiment the endogenous bacteroides, veillonella, lactic acid bacteria and enterococci in the virginiamycin treated cultures remained at the same concentration as those in the untreated control culture. The *E. coli* O157:H7 population dropped at a rate of one log/CFU/day until it reached a concentration of approximately 10^3 CFU/ml in all three cultures. The *E. coli* O157:H7 population remained at approximately 10^2 - 10^3 CFU/ml in the two virginiamycin treated cultures and at 10^1 - 10^2 CFU/ml in the untreated control. The results of this study suggest that a subtherapeutic level of 1.0 $\mu\text{g/ml}$ virginiamycin was not sufficient to perturb the microbial ecology of the culture such that *E. coli* O157:H7 was provided with a competitive advantage.

Key Words: Growth promotion, Competitive exclusion, *E. coli* O157:H7

1076 Effect of Organic Acids and Formaldehyde on Pellet Quality and Pellet Process Efficiencies. S. Moore, M. Neill, P. Bentley, R. Odgaard, and P. A. Welch*, *Kemin Americas, Inc.*

An organic acid containing compound (K-One brand Feed Treatment) and a 30% formaldehyde based compound were evaluated for their effects on pellet quality and pelleting efficiencies. Control elements, i.e., mash temperature, run time (min), pellet mill volts, and production rate per hour (2.9 MT/hr.) in the pelleting process were maintained constant. Percent pellets, Pellet Durability Index (PDI), amperage, motor load, horsepower, and relative electrical energy per ton (kWh/MT) were measured. A commercial broiler grower ration containing 65% corn, 27% soybean meal, and 3% meat and bone meal was used as a basal diet, to which the various chemical treatments were applied. Treatment inclusion rates of organic acids was 0.4%, and the 30% formaldehyde based compound was added at a rate of 0.3% (0.09% formaldehyde). No significant differences were observed in percent pellets or PDI values between the control and organic acid treatment; however, incorporating formaldehyde into the basal diet resulted in a significant decrease in percent pellets (3.14%) and PDI (4.87%). Motor load was similar for the control and the organic acid treatment, but increased significantly with the inclusion of formaldehyde into the basal diet. Organic acid treatment resulted in lower amperage and horsepower requirement as compared to the control and the formaldehyde treatment. Although relative electrical energy per ton values appeared to be numerically higher for formaldehyde treated feed, statistically all treatments were similar. In conclusion, it appears that the use of organic acids improve pellet quality when compared to formaldehyde, and organic acids reduced amperage, and horsepower requirements for pelleting broiler feed. Formaldehyde

in this study appears to have had a negative impact on pelleting process dynamics.

Key Words: Pellet Quality, Pelleting Efficiencies, Broiler Ration

1077 Phylogenetic analysis of cecum mucosal bacteria in broiler chickens. J. Gong¹, J.R. Chambers*¹, R.J. Forster², H. Yu¹, P. Sabour¹, R. Wheatcroft¹, and S. Chen³, ¹*Food Research Program, Agriculture & Agri-Food Canada*, ²*Lethbridge Research Center, Agriculture & Agri-Food Canada*, ³*Laboratory Service, University of Guelph, Guelph.*

The community structures of bacterial populations associated with cecal surface of broiler chickens were investigated by comparative DNA sequence analysis of 16S rRNA genes. Total DNA was extracted from bacteria collected from the cecal surface of ten 6-week-old chickens that were fed with standard commercial diets containing no antibiotics. One hundred and fifteen random clones of 16S rRNA genes were isolated for sequence analysis after PCR amplification with eubacterial primers. Phylogenetic analysis indicated that all cloned sequences were similar to low G + C Gram-positive bacteria. The cloned sequences showed large phylogenetic diversity within this group, with many sequences being related to cloned sequences from the human gut or from the rumen. There were 11 groups of sequences comprised of 4 or more closely related clones, and the largest group of sequences (34) were closely or distantly related to *Fusobacterium prausnitzii*. Of all the clones, at least 29% were related to butyrate-producing bacteria. The ecological/physiological significance of the predominant bacteria remains to be determined.

Key Words: Chicken, Bacteria, 16S rRNA

1078 Bioprocessing of poultry feather wastes using three feather-degrading microorganisms: fermentation characteristics, keratinases activities and biochemical properties. A. A. Onifade*¹ and N.A. Al-Sane¹, ¹*Department of Biological Sciences, Kuwait University, P.O. Box 5969, Safat 13060, Kuwait.*

Poultry feather accumulates as waste after slaughtering of the chicken; however, there exists the potential for its bioprocessing prior to recycling as animal feedstuff using feather-degrading microorganisms. Bioprocessing is environmentally friendly, low-energy consuming and an alternative to hydro-thermal processing, which appears not completely satisfactory. Three feather-degrading microorganisms: *C. zonatum*, *C. pannicola* and the *Streptomyces* (K) were used for bioprocessing of feather. *In vitro* biodegradation of poultry feather obtained from slaughtered 7-week old white-feathered broilers was carried out by inoculating the spore suspension of feather-degrading microbes in Keratin Salt Medium containing $g\ l^{-1}$: 20 partially milled feather; 0.5 $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$; 0.46 KH_2PO_4 and 1.0 K_2HPO_4 followed by incubation at 28 °C for 9 days at 200 rpm until the feather was completely degraded. The extracellular keratinases were separately recovered from a cell-free extract of the growth media of the three microbes by 80% $(\text{NH}_4)_2\text{SO}_4$ saturation and further subjected to biochemical assays. Results showed that the three fermentation media became alkaline terminally and highest substrate consumption of 75.6% was by *Streptomyces* (K) achieved because of its highest proteolytic activity. The three microbes synthesized *de novo* and export considerably active keratinases into the culture media, which were recoverable. Production of keratinase by *Streptomyces* (K) tended to decrease with time, whereas both *Chrysosporium* species demonstrated increasing production, but *C. zonatum* produced greater amount of keratinase than *C. pannicola*. The data obtained suggest that the major keratinases produced by *C. zonatum* and *Streptomyces* (K) are metalloproteases while a mixture of serine and metalloprotease are produced by *C. pannicola*. The optimal pH and temperature were: 8.0; 9.0; 8; 50 °C; 65 °C and 40 °C for *C. zonatum*, *Streptomyces* (K) and *C. pannicola*, respectively. The biochemical adjuncts added to the keratinase assay milieu elicited improved activities especially organic detergents, sulfurhydryl group protectors and reducing agents and the keratinase tolerated some common organic solvents. In conclusion, poultry feather wastes were bioprocessed and microbially digested, multi-component, relatively thermostable keratinases were produced and both products are amenable to animal feeding operations.

Key Words: Bioprocessing of poultry feather, Feather-degrading microorganisms, Fermentation and keratinases characteristics

1079 Effect of timing of hypobaric exposure on the incidence of ascites syndrome in broilers. J. M. Balog*¹, N. B. Anthony², M. A. Cooper², B. D. Kidd^{1,2}, G. R. Huff¹, W. E. Huff¹, N. C. Rath¹, and Y. K. Kirby¹, ¹PP&PSR/ARS/USDA, Fayetteville, AR, ²University of Arkansas, Fayetteville, AR.

Ascites is a metabolic disease of fast growing meat-type birds, that can be induced by rearing birds in a hypobaric chamber. The hypobaric chamber simulates high altitude by operating under a partial vacuum, leaving the birds with less available oxygen. A study was conducted to determine if birds exposed to simulated altitude for varying amounts of time would, when moved to local altitude, still develop ascites and if the reverse was true for birds moved from local altitude to high altitude. Three replicate trials were conducted utilizing 480 male broilers for each trial. Half the birds were assigned to the hypobaric chamber and the other 240 were placed in an environmentally matched local altitude chamber. Within each chamber, birds were randomly assigned to one of four treatments. The control birds remained at their initial altitude for the entire 6 wk trial. Birds in Treatment 2 remained at their initial altitude for 2 wk, and were then moved to the other chamber. Treatment 3 birds remained for 3 wk, and Treatment 4 birds remained for 4 wk at their initial altitude before being moved. All birds and feed were weighed weekly. Necropsies were conducted daily to determine cause of death. At the end of 6 wks, blood samples and organ weights were collected and all birds were examined for signs of ascites. In all three trials, time spent at simulated high altitude significantly affected ascites mortality and body weight. Birds that remained at high altitude for the duration experienced the highest ascites mortality while birds that were never placed at high altitude had the least ascites. As the amount of time that a group spent at high altitude increased, so did their ascites mortality. Body weights were negatively correlated with the amount of time spent at high altitude. In general, when birds were moved to high altitude, it took 2 wks of exposure before a significant increase in ascites incidence was noted. Conversely, when birds were moved from high altitude to low, it took 2 wks before ascites mortality significantly declined.

Key Words: Ascites, Hypobaric, Broilers

1080 Campylobacter jejuni Isolation Trends of Broilers Reared on Different Bedding Materials. W Willis*, C Murray, and W Willis, *North Carolina A&T State University.*

An experiment was conducted to evaluate different bedding materials on *Campylobacter jejuni* isolation with broiler chickens. Five bedding types were utilized in floor pens: (1) pine wood shaving; (2) sand; (3) corn-cob; (4) red cedar shaving and (5) wheatstraw. Each treatment was replicated three times with five birds placed on day 0, 3, and 6-d in each pen. Samples were taken 3, 6, 9, 12 and 15-d post placement in each treatment. All litter treatments had been previous utilized by a *Campylobacter jejuni* experimental infected flock. No chicks tested positive in any of the treatments at 0, 3 and 6-d placement for 3-d cloaca sampling. The longest time that chicks tested negative was 12-d at the 0, 3, and 6-d placements. Chicks placed on the pine and corn-cob bedding generally were the first to test positive, whereas, the cedar and sand were the last to test positive for *C. jejuni* at all placement times. All chicks crop tested for *C. jejuni* at 49-d of age were 100% positive for all treatments. Carcass yields varied for each treatment with 71.6, 75.1, 73.9, 73.8 and 71.2, respectively. The results from this study indicates that bedding materials can influence or delay the isolation of *C. jejuni* but not totally inhibit it.

Key Words: *Campylobacter jejuni*, Broilers, Bedding

1081 Multi-Phase Versus Single-Phase Feeding During the Broiler Starter Period; Effects on Performance and Nitrogen Excretion. N. Nasril*, C. Zhang, A.U. Haq, J. Carey, and C.A. Bailey, *Texas Agricultural Experiment Station.*

Two experiments were conducted to evaluate the effects of a multi-phase feeding program in which the nutrient content of the diet was changed every 24 hours versus a single-phase feeding program in which a single diet was fed over a 21-day growing period. In Experiment 1, 144 day-old straight run broiler chicks were randomly placed in 24 separate battery brooder pens and fed either a broiler starter diet containing 22% protein (3146 kcal ME/kg) or a linear blend of two diets so that birds received a diet containing 24% protein (3124 kcal ME/kg) on Day 1 and 20% protein (3168 kcal ME/kg) by Day 21. Experiment 2 was similar to Experiment 1 with the exception that 24 day-old straight run broilers were

individually caged and the control diet contained 23% protein while the blended diet ranged from 26 to 20% protein. Poultry metabolizable energy was maintained at 3200 kcal ME/kg. Multi-phase feeding had no significant influence on feed consumption, daily gain, feed conversion or net fecal nitrogen in either experiment.

Key Words: Multi-phase feeding, Broilers, Nitrogen excretion

1082 Limitation of *Salmonella enteritidis* colonization by diets containing low calcium and low zinc. S.C. Ricke*¹, Y.M. Kwon², C.L. Woodward¹, J.A. Byrd², D.J. Nisbet², and L.F. Kubena², ¹Texas A&M University, College Station, Texas/USA, ²USDA-ARS, SPARC, College Station, Texas/USA.

The use of feed deprivation to induce molting and stimulate multiple egg-laying cycles in laying hens is a common practice in commercial egg production. An increased susceptibility to *Salmonella enteritidis* (SE) and an increased risk of SE positive eggs and internal organs has been observed under laboratory conditions, probably due to the stress involved in feed deprivation. There is the need to test other methods that stimulate multiple egg-laying cycles without the increased risk of SE. Leghorn hens over 50 wk of age were divided into treatment groups of 12 hens each and placed in individual laying hen cages. One wk prior to dietary changes, hens were exposed to an 8-h light and 16 h-dark photoperiod that was continued throughout the 9-day experiment. Individual hens in all treatments were challenged orally with 10⁴ cfu of SE on the fourth day. Treatments consisted of full-fed hens (non-molt, NM), non-fed hens (molt, M), hens fed a low calcium diet (LC), and hens fed the low LC diet supplemented with 110 mg zinc/kg of diet (LC-ZN). When compared with the NM treatment, weight losses were higher and water consumption was increased in hens fed the LC and LC-ZN diets. The number of crop and ceca culture positive hens and the numbers of SE per crop and per gram of cecal contents were lower in the LC and LC-ZN treatments than in the M treatment, and were comparable to the NM treatment. Invasion of the liver, spleen, and ovary by SE was similar to the NM treatment, which was significantly lower (P < 0.05) than the M treatment. These dietary regimens may prove to be useful for reducing the incidence of SE in eggs and internal organs during and following molting of laying hens.

Key Words: *Salmonella enteritidis*, Laying hens-Molting, Diets-zinc-calcium

1083 *Salmonella* Typhimurium Virulence Response to Poultry House Water as Measured by *hilA:lacZY* Fusion. J. D. Nutt*, K. L. Medvedev, C. L. Woodward, S. D. Pillai, and S. C. Ricke, *Texas A&M University, College Station, TX, USA.*

Salmonella is regarded as a primary foodborne pathogen commonly found in the gastrointestinal tract and internal organs of poultry. Recent studies have shown *Salmonella* to be capable of surviving in several types of aquatic habitats. Depending on environmental factors of the aquatic habitat, the bacteria cells may be induced to express virulence genes. Our objective in this study was to determine virulence expression in a strain of *Salmonella* Typhimurium when exposed to fresh versus standing water samples taken from the drinking containers of commercial laying hens. The caging facility contained two rows of 30 cages placed back to back for a total of 60 cages housing 58 hens. Water was supplied to each cage by a U-shaped pipe with individual outlets to each cage. The 60 cages were divided into four quadrants. Quadrant one was the closest to the initial water source while quadrant four was the greatest distance from the origin of the water source. Water from the containers were sampled, refilled and sampled again. Each water sample (1.5ml) was inoculated with 0.120ml of a *hilA:lacZY* fusion strain of *S. Typhimurium* inoculum and incubated for two hours. After incubation, β -galactosidase assays were performed on the samples to determine virulence expression with brain heart infusion (BHI) broth serving as a control. BHI values ranged from 40-45 Miller units while water samples displayed Miller units in the range of 300-500. Results showed that there was a significant difference (p<0.05) in virulence expression between the four quadrants in the fresh water samples. However, no significant difference was observed between quadrants for the standing water samples. Both standing and fresh water samples gave a 5-10 fold increase of virulence expression as compared to BHI.

Key Words: *Salmonella*, poultry water, virulence

1084 Differential response in fertility of broiler breeder males selected for the sperm quality index prior to heat exposure. A. G. Karaca*, H. M. Parker, J. B. Yeatman, and C. D. McDaniel, *Mississippi State University, Mississippi State, MS.*

Heat stress (H) is deleterious to broiler breeder reproductive performance. The present study was undertaken to determine if fertility of males with a higher sperm quality index (SQI), prior to exposure to H, is more susceptible to high ambient temperatures than that of males with a lower SQI. Cobb males (108) were individually caged in six temperature controlled rooms. Males were tested twice for the SQI and then placed into four SQI treatment groups as follows: best (B), good (G), fair (F), and poor (P). The SQI groups represented the four SQI population quartiles. Four or five males from each SQI group were placed in every room. After a 29 wk acclimation period, three rooms were heated to 35°C, and the other three rooms were maintained at a constant 22°C as controls (C). For each SQI group in each room, 15 Leghorn hens were artificially inseminated (50 million sperm/hen) once a week for 8 wk for fertility observations. Sperm concentration, sperm viability, and the SQI were evaluated for each male on a weekly basis. Linear contrasts were used to compare males in the top 75% of the SQI population (B+G+F) to males in the lowest 25% of the SQI population (P). Body weight, sperm concentration, SQI, and fertility of the P males was lower than that of the other three SQI groups. Body temperature of the top three SQI groups was increased by exposure to heat stress, but body temperature was not altered by H in the P group. Also, mortality was elevated and feed consumption was decreased by exposure of males to high ambient temperature. Fertility, sperm viability, and SQI of the top three SQI groups was decreased by exposure to high ambient temperature; however, the same characteristics of the P males were not affected by heat exposure. In conclusion, high ambient temperatures had a more dramatic impact on the semen quality and fertility of males with a higher SQI as compared to those with a lower SQI prior to heat exposure.

Key Words: fertility, sperm quality index, heat stress

1085 Employing Ultrasound Technology to Measure Testicular Development in Broiler Breeder Roosters. L. J. Richardson*¹, A. B. Caudle¹, and J. L. Wilson¹, ¹*The University of Georgia.*

An ultrasound (Aloka SSD-500V) fitted with a linear prostate probe (UST-660 7.5MHz-16mm) was used to access testicular development in broiler breeder males. The objective was to characterize the size of the testes without killing or harming the birds. In order to obtain diagnostic images, bird position, probe placement, lubricant mixture, and feeding schedule had to be determined. The birds were fed one hour prior to the ultrasound procedure to reduce intestinal fragility and the presence of lower gastrointestinal feces. A lubricant (J-Lube) was used to ease probe insertion, decrease the possibility of intestinal tract damage, while increasing ultrasound image quality.

The trial was completed with twelve, 65 wk old broiler breeder males. Five ultrasound images were attempted of each rooster over a four wk period. Several problems were identified to interfere with probe placement and image quality: limited abdominal cavity space to maneuver probe, close proximity of abdominal air sacs and abdominal aorta to testes, and narrowing of large intestine at the branch of the ceca. Roosters were held in a dorsal position by an assistant to reduce bird stress and allow for easy probe insertion through the cloaca to a depth of 12 cm. The longitudinal scanning face of the probe was inserted parallel with the spinal column and came to rest between the testes. In this position, the scanning face of the probe was rotated 30-40 degrees in either direction to obtain an ultrasound image of each testis. Semen collection was attempted from the roosters before ultrasound images were obtained (semen collected from 8 of the 12 roosters). A similar number of males ejaculated semen 3-7 days after the ultrasound procedures indicating no long term detrimental effect of probe insertion.

Key Words: Ultrasound, Testes, Broiler breeder males

1086 The Effects of Chlorine and Hydrogen Peroxide at Various Concentrations on Total Bacteria and Coliform Counts in Poultry Drinking Water. J Zhang*, D McGhee, and S VanBoekel, *Cold Springs Farm Ltd. Thamesford, Ontario, Canada.*

Water samples were collected from the drinkers in the poultry barns on four farms and were cultured on petrifilm plates for the total aerobic bacteria and coliform counts. Water in the poultry barns on all farms was treated either with chlorine (Cl₂) or with hydrogen peroxide (H₂O₂). The Cl₂ levels in the water were about 3-4 ppm and the H₂O₂ levels were about 40-50 ppm. All the levels were measured at the beginning points of water lines, however, both Cl₂ and H₂O₂ concentrations were much lower in the water samples collected from the drinkers (below 0.5 ppm for Cl₂ and below 30 ppm for H₂O₂). After 24 hour incubation at 37 °C, the total aerobic bacteria counts were too numerous to count (TNTC) for all samples and coliforms were recovered for these samples in which H₂O₂ levels were below 30 ppm and Cl₂ level was not detected. However, there was no coliform count from the samples in which Cl₂ levels were discovered (> 0 ppm). To continue this investigation, water sample contaminated with bacteria was used. One sample was untreated as control and some samples were treated either with Cl₂ at 0.5, 1, 1.5, 2, 2.5, 4, and 6 ppm or with H₂O₂ at 20, 40, and 60 ppm as in final solutions in the laboratory. From the control sample, the total aerobic bacteria count was TNTC and coliform count was 69/mL. From the samples treated with Cl₂, the aerobic bacteria counts were 2400, 3, and 2/mL when Cl₂ concentrations were at 0.5, 1 and 1.5 ppm, respectively. There was no bacteria count in all samples when Cl₂ concentrations were at 2 ppm and higher levels. While, the coliform count was zero in each sample treated with Cl₂ at all concentrations. From the samples treated with H₂O₂, the total aerobic bacteria were TNTC and there were countable numbers of coliforms in all samples. However, the coliform counts were decreased when the H₂O₂ concentrations were increased from 20 to 60 ppm. From these investigations, the results indicate that when Cl₂ is used as a disinfectant in the poultry drinking water, it plays a better role in the deductions for total bacteria counts, especially for coliform counts over H₂O₂. Further study may be required to investigate H₂O₂ effect on bacteria deduction in poultry drinking water at higher concentration.

Key Words: Chlorine, Hydrogen Peroxide, Bacteria

1087 Prevalence of *Campylobacter* in a Turkey Production Facility. A. S. Kiess* and P. B. Kenney, *West Virginia University.*

Campylobacter ingestion may cause campylobacteriosis in humans with most cases being linked to poultry products. In order to reduce *Campylobacter* in turkey products, frequency of *Campylobacter* colonization in live turkeys must be reduced. One turkey flock, with two genetic lines, was sampled for *Campylobacter*. Gastrointestinal tracts and box liners were collected when poult were placed, and water and fecal samples were taken at specified times throughout a 20-week production cycle. Each GI tract and box liner sample, a 5.2-cm square, was removed and placed in a sterile stomacher bag containing 100 or 25-mL nutrient broth (#2), respectively. A 100-mL water sample was transferred from each drinker to a sterile 250-mL bottle, and fecal droppings were placed in sterile plastic bags. All samples were packed on ice and transported to the microbiology lab for *Campylobacter* isolation. Following mixture of feces with nutrient broth, a sample was directly plated onto a Campy-Cefex agar plate. Water samples were filtered through a 0.4-micron filter; the filter was then placed face down onto a Campy-Cefex agar plate. Twelve plates were placed in a gallon, ziplock bag, flushed (85% N₂, 10% CO₂ and 5% O₂) sealed, and incubated at 40 to 42 °C for 36h. Presumptive positives were confirmed by latex agglutination. *Campylobacter* was present in 59.7% of all samples by week three of production, and it remained at this level throughout production. Frequency of detection was higher in females (63.1%) than males (56.3%). The higher frequency in females may be the influence of the males on female behavior in adjacent pens. The high prevalence of *Campylobacter* in this flock supports the need for implementation of preharvest practices to reduce this food borne pathogen in turkeys at harvest.

Key Words: Turkeys, *Campylobacter*, Preharvest

1088 Does genetic selection for contrasting adrenocortical responsiveness influence underlying sociality in Japanese quail? R. H. Marin^{*1}, R. B. Jones², D. G. Satterlee¹, and G. G. Cadd¹, ¹Dept. of Poultry Science, Louisiana State University Agricultural Center, Baton Rouge, LA 70803, US, ²Roslin Institute (Edinburgh), Midlothian EH25 9PS, Scotland.

Inappropriate levels of sociality (motivation to be near conspecifics) may engender fear and distress, high levels of which can seriously damage poultry productivity and well-being. Thus, low sociality birds may be ill-suited to housing in very large groups. Genetic selection of Japanese quail for a dampened (LS, low stress) rather than exaggerated (HS, high stress) adrenocortical response to brief restraint is associated with decreased fearfulness and a non-specific reduction in stress responsiveness. Because sociality and fear may be linked in certain circumstances, the present study compared underlying sociality in chicks of the LS and HS lines in two test situations. In Experiment 1, social proximity was evaluated by filming undisturbed same-line groups of LS and HS chicks in their home cages; during subsequent analysis of the videotapes we then measured clumping and the distance between the two furthest birds at regular intervals. In Experiment 2, the responses of individually-tested chicks were measured in a runway when the goal box at the opposite end contained two other chicks (1 LS, 1 HS). Social proximity was greater ($P < 0.03$) in LS than HS quail and the LS birds tended to segregate more ($P < 0.10$). Similarly, once the quail had reached the runway zone nearest the goal box, LS birds spent a greater proportion of the remaining time in close proximity to the stimulus birds ($P = 0.04$) than did HS ones. Social proximity in the home cage and affiliation responses in a runway are widely considered to be positively related to underlying sociality. Therefore, the present findings clearly suggest that underlying sociality is greater in quail selected for low rather than high adrenocortical stress responsiveness

Key Words: Adrenocortical responsiveness, Japanese quail, Genetic selection, Sociality

1089 Early T-maze behavior, puberty and egg production in Japanese quail selected for contrasting adrenocortical responsiveness. R. H. Marin^{*1}, D. G. Satterlee¹, G. G. Cadd¹, and R. B. Jones², ¹Dept. of Poultry Science, Louisiana State University Agricultural Center, Baton Rouge, LA 70803, ²Roslin Institute (Edinburgh), Midlothian EH25 9PS, Scotland.

Broiler chicks that traversed a T-maze quickly to reinstate contact with their companions (HP, high performance) then grew faster, showed greater sociality and lower plasma corticosterone (C) responses to an acute stressor than did slower (LP, low performance) chicks. Genetic lines differing in adrenocortical responsiveness are powerful tools for studying the relationships between behavior, stress and performance. Herein we asked if early T-maze behavior is related to the attainment of puberty and to egg production in Japanese quail selected for low (LS) or high (HS) plasma C response to restraint. At 3 d of age, 196 HS and 189 LS quails were tested in a T-maze and categorized as HP or LP if running times were < 25 s or > 100 s, respectively. They were housed in mixed-category, mixed-line groups in brooder batteries until 4 weeks when they were caged in same-line, same-category pairs of 1 male and 1 female until 14 weeks. Thus, there were 4 treatment combinations, i.e., 19 HP-LS, 21 HP-HS, 23 LP-LS and 24 LP-HS pairs. Egg records were kept from the first oviposition for the next 8 weeks. HP birds reached puberty sooner than LP ones as shown by reductions in age at first egg and at 25% egg production (ANOVA, $P < 0.02$). Post-hoc tests showed that age at first egg and at 25% egg production were lower ($P < 0.05$) in HP-LS than LP-HS pairs. Overall hen-day egg production (HDEP) was greater (repeated measures ANOVA, $P < 0.04$) in HP than LP quail. A numerical trend towards greater overall HDEP (+5%) in LS than HS quail failed to reach significance ($P < 0.34$). Our results suggest that rapid negotiation of the T-maze was associated with accelerated puberty and an associated increase in HDEP in quail of two genetically diverse lines. These findings strengthen our proposal that this simple, non-invasive test could be a useful selection criterion for breeding programs to improve productivity

Key Words: Japanese quail, T-maze behavior, puberty

1090 Effect of age, body weight, and sex ratio on fertility and hatchability in the Japanese quail (*Coturnix coturnix japonica*) under subtropical conditions. Gehan Ragheb^{*}, H. El-Hammady, and M. Abdelnabi, Assiut University, Assiut, Egypt.

The purpose of this experiment was to study the effect of age, body weight and sex ratio on fertility and hatchability in the Japanese quail raised under subtropical conditions. Three hundred, newly hatched chicks were raised in brooders under standard temperature, humidity and photoperiod regimen until puberty. Birds from both sexes were divided according to their weights into high (HBW; 160-180 gr.) and low (LBW, 120-150 gr.) body weight. Each body weight group was divided into two subgroups; the male/ female ratios were 1:1 and 1:2, respectively. A total of 400 eggs (100/subgroup) were collected over the course of 13 time periods, each consisted of 28 days. These eggs were incubated and then measurements of fertility and hatchability were determined. The results from this experiment showed highly significant differences ($P < 0.01$) in fertility and hatchability in all subgroups with respect to age. No significant differences were found in both traits between groups (HBW and LBW) and between sex ratio (1:1 and 1:2) in all periods. The highest fertility was 95.0; 95.7% and 95.8; 95.9% while the highest hatchability was 82.1; 85.7% and 90.7; 87.8 % in HBW and LBW at sex ratio of 1:1 and 1:2, respectively. Therefore, HBW and 1:2 sex ratio is considered economically cost-efficient for quail breeders under subtropical conditions.

Key Words: Quail, Sex ratio, Fertility and hatchability

1091 Optimum Timing of Amino Acid Injections in Broiler Breeder Eggs. Y. Ohta^{*1}, T. Yoshida², and M. T. Kidd¹, ¹Department of Poultry Science, Mississippi State University, Mississippi State, MS 39762, ²Nippon Veterinary and Animal Science University, Tokyo, Japan 180-8602.

Amino acid (AA) injection *in ovo* in broiler breeder eggs results in heightened BW at hatch. However, recent research has indicated that *in ovo* AA injections into the yolk and extra-embryonic coelom, but not the amniotic cavity, result in optimal responses to AA. Because egg constituents and cavities change over time, we conducted this study to determine the optimal injection time for AA *in ovo*. An AA solution, identical to the AA pattern of the egg, was injected over time in three experiments and subsequent BW and hatchability of chicks were measured. In Experiment 1, the AA solution was injected into eggs on Days 1, 3, 5, 7, 9, 11, and 14 of incubation. In Experiment 2, the AA solution was injected into eggs on Days 7, 8, 9, 10, 11, 12, 13, and 14 of incubation. In Experiment 3, the AA solution was injected into eggs on Days 14, 15, 16, 17, 18, and 19 of incubation. *In ovo* AA injections at Days 1 and 7 reduced ($P < 0.05$) hatchability. Injection of AA *in ovo* at Days 9 and 14 in Experiment 1, Days 9, 11, and 14 in Experiment 2, and all levels in Experiment 3 increased ($P < 0.05$) relative chick BW to egg weight over that of chicks from eggs not injected with an AA solution. The optimal time to inject AA solution *in ovo* in broiler breeder eggs may be Day 14 of incubation.

Key Words: Amino Acid, *In ovo*, Chick Weight

1092 Effect of number of birds per cage on the reproductive performance of Japanese quail breeders. J.F. Obregon¹, G. Contreras¹, A. Montoya¹, M.E. Gamez¹, and R. Barajas¹, ¹FMVZ-Universidad Autonoma de Sinaloa (Mexico).

To determinate the effect of the number of birds per cage on the reproductive performance of Japanese quail breeders, a complete randomized experiment was conducted with one hundred sixty Japanese quail (40 males and 120 females; 16 weeks old). Treatments consisted of: 1) Six females and two males allocated in a 0.25 x 0.3 m wire cage (2-M; and 2) Three females and one male allocated in a 0.25 x 0.15 m wire cage (1-M). Birds were fed a diet containing 21% CP and 2.9 Mcal DE/kg. After an adaptation period of seven days, eggs were collected during six weeks. Dead animals were replaced with birds of the same age and sex. Number of eggs hatched, was 10% higher ($P < 0.02$) with the 1-M treatment (46 vs. 51 egg). Percent hatching was increased ($P < 0.01$) by 22% as result of one male and three females (62.8 vs. 76.8%). Hatchability as a mean value was 54.2% and was not affected ($P > 0.02$) by treatments. The number of hatched quails per day, was improved ($P < 0.03$) by 24%

for 1-M treatment (25 vs. 20 quails). It is concluded, that allocation of one male and three females per cage, is a better management system than placing two males and six females in the cage.

Key Words: Japanese quail breeders, population size

1093 Multiple-objective programming to reduce ration cost and nutrient excretion. P.R. Tozer* and J.R. Stokes, *The Pennsylvania State University, University Park, PA.*

Typical dairy rations are formulated to meet the nutrient requirements of the cow at the least cost. This approach is single objective oriented, and that is to minimize cost. In this paper we examine the use of multiple objective programming to formulate rations that minimize cost, and minimize phosphorus and nitrogen excretion. A ration formulation model was developed using the National Research Council's recommendations for nutrient requirements, and functions for protein intake and digestion, a phosphorus excretion function, and a set of prices of representative feeds for the northeastern United States. A "standard" cow was used in the model, this cow weighed 600kg, produced 30 kg of milk per day with a fat content of 3.5 per cent and was gaining 300 g per day. The cost of the minimum cost ration was \$2.81 per day and consisted

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1094 Feeding neonatal calves high levels of milk replacers (MR) with different protein and fat levels. T. M. Hill*, J. M. Aldrich, A. J. Proeschel, and R. L. Schlotterbeck, *Akey, Inc., Lewisburg, OH.*

Recent research with neonatal calves not receiving starters has suggested that feeding MR at high levels (over .6 kg daily) and with a high crude protein (CP) content (26 # 30%) will result in more efficient and faster gains. However, trials with a 20% CP MR fed at .57 vs. .45 kg daily observed no differences in gains because of reductions in starter feed intake with increased MR fed. We conducted a series of trials to examine how feeding rate and level of CP and fat in MR affect calf performance. In all trials, bull calves were randomly assigned to MR treatments and fed fixed amounts of MR (all milk CP plus synthetic lysine and methionine) with free-choice starter for 6 weeks. Calves were fed starter alone after 6 weeks. Calves were weighed initially and weekly. Starter intake was measured and fecal scores and medical treatments recorded daily. In all trials, a 20% CP, 20% fat MR fed at .45 kg daily served as a control treatment. Average initial body weights were 40 to 42 kg. Feeding a 28% CP, 20% fat MR stepped-up to 1.13 or 1.36 kg daily resulted in no increase in gains, increased ($P < .1$) fecal scores and medical treatments, and reduced ($P < .1$) starter feed intake by 7 weeks of age compared to the control. Feeding a 28% CP, 20% fat MR at .68 kg daily increased gains, medical treatments, and fecal scores, but decreased starter intake vs. the control ($P < .1$). When .68 kg daily of a 13% fat MR was fed with CP levels from 20 to 28%, gains increased ($P < .1$) in a quadratic manner (optimum of 26%) and starter intake was no different from the control. When .68 kg daily of a 24% CP MR was fed with fat levels between 11 and 17%, gains increased ($P < .1$) linearly and starter intake was no different from the control. These results indicate that MR fed should be limited (to near .68 kg daily) so not to depress starter intake and that the CP (optimum near 26%) and fat (optimum near 17%) levels critically impact performance.

Key Words: Protein, Fat, Calves

1095 Feeding neonatal calves milk replacers (MR) containing egg proteins. T. M. Hill*, J. M. Aldrich, A. J. Proeschel, and R. L. Schlotterbeck, *Akey, Inc., Lewisburg, OH.*

Alternative crude protein (CP) to milk CP interest the calf raising industry because of the high price of milk CP. Soy CP sources are popular because of their low cost relative to milk CP sources but, depending upon the type and level included in a milk replacer, performance can be compromised. Our objectives were to 1) evaluate how calf performance is affected by the level of milk CP replacement with egg CP, 2) compare two whole egg sources, and 3) combine egg, soy protein concentrate (SPC), and milk proteins in MR. In each trial, 50 bull calves were randomly assigned to MR treatments and .45 kg of MR was fed with free-choice starter for 6 weeks. Calves were fed starter alone after 6 weeks.

principally of alfalfa hay, straw, dry distillers grain, bakery product and dry shelled corn. The ration contained less than 100g of mineral supplements. The "standard" cow excreted 279 g/day of nitrogen and 32.1 g/day of phosphorus. Rations were also formulated to minimize nitrogen and phosphorus. The results of the three single objective models were combined into a multiple-objective programming model to minimize the maximum deviation from the goals generated in the single objective models. The multiple objective models resulted in marginal reductions in nitrogen and phosphorus excretion. The most marked change in ration formulations occurred when the efficiency of phosphorus utilization was increased. The base ration contained an unacceptably large proportion of straw and no corn silage, hence other multiple objective rations were formulated to reduce the straw and increase the corn silage contents. These rations increased the costs of the ration by 0.05 - 0.35 per day and marginally increased the level of nitrogen and phosphorus excreted. Another result of this ration formulation research is that all rations formulated contained less than 100 g/day of mineral supplements, indicating that the use of these supplements is a costly expense and any amount of supplement fed over those formulated leads to excretion of excess nutrients.

Key Words: Ration formulation, nutrient management, mathematical programming

Calves were weighed initially and weekly. Starter intake was measured daily. Fecal scores and medical treatments were recorded daily. In all trials, a 20% CP (from milk protein) and 20% fat MR served as a control treatment. The egg CP source was used to replace a percentage of the total protein in the MR. Average initial body weights were 41 to 43 kg. In two trials, 10, 20, and 30% egg CP from source A and 20% egg CP from source B replaced whey CP. Increasing egg CP from source A resulted in a quadratic response ($P < .1$) of gain and starter intake with 30% being inferior to other lower levels of egg and the control. The 20% egg CP from source B supported lower ($P < .1$) gains and starter intakes than the control. Additionally, three trials were conducted to compare 15% egg CP from source A, 15% SPC CP, and 70% milk CP in a MR to the control MR. There were no differences in gains and starter intake. Fecal scores and medical treatments were not different from the control when egg CP from source A was used alone or combined with SPC. Egg CP can be used successfully as a partial replacement for whey CP in calf MR, but source of egg CP differs.

Key Words: Protein, Egg, Calves

1096 Protein levels for neonatal calf starters. T. M. Hill*, J. M. Aldrich, A. J. Proeschel, and R. L. Schlotterbeck, *Akey, Inc., Lewisburg, OH.*

Previous research has suggested that approximately 18% crude protein (CP; as-fed basis) is adequate for neonatal calf starters, however, some feed companies and universities have suggested that higher levels of CP may be required. To investigate CP requirements for calf starters we fed calves starters that contained graded levels of CP along with either a 20% CP (all milk CP plus synthetic lysine and methionine), 20% fat milk replacer at .45 kg daily (trial 1) or a 26% CP (all milk CP plus synthetic lysine and methionine), 17% fat milk replacer at .68 kg daily (trial 2). In each trial, 50 bull calves were randomly assigned to starter protein levels of 18, 20, 22, 24, and 26% as-fed basis (88% DM) and fed milk replacers and free-choice starter for 6 weeks. Calves were fed starter alone after 6 weeks. The starters were a corn-based pellet with 15% wheat midds and a fixed protein blend replacing corn with elevated levels of CP. The protein blend consisted of 75% soybean meal (48% CP), distiller's grains, blood meal, corn gluten meal, and fish meal. Mineral and vitamins levels were equal among starters. Calves were weighed initially and weekly. Starter intake was measured daily. Fecal scores and medical treatments were recorded daily. Hip widths and body condition scores was measured initially and every two weeks. Data were analyzed as a completely randomized design with linear, quadratic, and cubic contrasts relative to level of protein in the starters. Average initial body weights were 40 and 41 kg. In both trials, there were no differences ($P > .1$) in any measurement taken. These results indicate that neonatal calves fed 20% CP, 20% fat milk replacers at .45 kg daily and

26% CP, 17% fat milk replacers at .68 kg daily do not require starters with protein levels exceeding 18% CP (as-fed basis).

Key Words: Protein, Calves

1097 Behaviour and meat quality of veal calves receiving solid feeds for welfare purpose. G. Cozzi^{*1}, F. Gottardo¹, S. Mattiello², E. Canali², G. M. Burato¹, S. Segato¹, and I. Andrighetto¹, ¹University of Padova, Italy, ²University of Milano, Italy.

Behaviour, growth performance, carcass and meat quality of veal calves fed a traditional milk replacer diet (C) were compared to those obtained from calves fed the same diet plus 250 g/head/d of dried beet pulp (BP) or wheat straw (WS). The study lasted 160 d and used 138 Polish Friesian calves which were assigned to the 3 dietary treatments according to their initial BW. In comparison to C, calves fed WS diet reduced the frequency of abnormal oral behaviors throughout the fattening period. The WS calves showed also a higher chewing activity until the 17th wk of the trial. Subsequently, their chewing activity was similar to C calves likely because the daily dose of roughage became limiting. Behaviour of C and BP was similar. The provision of both solid feeds did not affect milk replacer intake, but it improved calves health status reducing the incidence of medical treatments. In C calves, iron intake throughout the fattening period was 6.34 g. Feeding WS and BP diets significantly increased total iron intake by 41 and 130% respectively ($P < .001$). However, before slaughtering, only BP calves showed hemoglobin and plasma iron concentrations higher than the C ones. Therefore, iron provided by WS was less available for the calf metabolism, likely because it was bound by NDF. Only feeding BP increased calves ADG (1178 g/d) ($P < .01$), whereas C and WS were similar (1078 and 1100 g/d, respectively). Both solid feeds led to empty fore stomachs heavier than C without affecting dressing percentage. The administration of BP resulted in a better carcass conformation than C and WS, but it had a detrimental effect on carcass colour which was the darkest. Consistent with this result, meat colour of BP calves was darker than C and WS. In conclusion, a solid feed with a high roughage value and a low bioavailability of iron, such as wheat straw, has shown to improve veal calves welfare allowing the production of veal meat which fulfills the colour standard required by the market.

Key Words: veal calf, solid feeds, behaviour and meat quality

1098 Effects of milk replacer fermented with yogurt culture on performance and health of dairy calves. S.C. Chan^{*}, Department of Animal Science, Chinese Culture University, Taiwan.

The objective of the study was to determine effects of non-medicated milk replacer fermented with yogurt culture on performance and health of calves and to compare economic benefit and performance of calves weaned at different time. Twenty-four female Holstein calves were randomly assigned at five days of age to one of 4 treatments in a completely randomized block design with 2 x 2 factorial arrangement of treatment. Factors were: (1) weaning time: 6 or 8 weeks; (2) milk replacer (MR): MR fermented with yogurt culture or MR without adding yogurt culture. Calves were fed colostrums twice daily through nipple bottles for 4 days. During the study calves were housed in individual, elevated calf crates. Since day 5, calves were fed non-medicated fermented MR that contained yogurt culture or non-medicated MR. A commercial, calf starter was fed "ad libitum" from day 5 to the end of trial. Body weight, wither height and heart girth were recorded when calves were on trial, and at the end of 3, 6 and 8 weeks of age. Rectal temperature and incidence of all health disorders were recorded daily. Fecal consistency scores for calves were recorded twice daily. Total bacterial, lactic acid producing bacteria, and coliform counts were determined at day 5, and at the end of 3, 6 and 8 weeks of age. Calves fed yogurt cultured MR had higher lactic acid bacterial and lower coliform numbers at week 3 and 6 ($P < 0.05$). Fecal consistency scores and days calves suffered diarrhea tended to be lower for calves fed cultured MR. Body weight gain from day 5 to week 3 tended to be lower for calves fed cultured MR than those fed regular MR ($P < 0.10$). Results also indicated that calves weaned at week 6 tended to have higher water intake and starter intake from week 6 to week 8 than those calves weaned at week 8 ($P < 0.10$).

Key Words: Calves, Milk Replacer, Yogurt Culture

1099 Absorption of immunoglobulin G in calves fed colostrum or colostrum replacement and animal plasma in milk replacer. C. M. Mowrey^{*1}, R. E. James¹, J. D. Quigley, III², and M. L. McGilliard¹, ¹Virginia Tech, Blacksburg VA, ²American Protein Corporation, Ames IA.

Newborn Holstein (n = 48) and Jersey (n = 30) calves were studied to compare the absorption of immunoglobulin G (IgG) from maternal colostrum (n = 39) or a colostrum replacement product derived from bovine serum (n = 39). Calves were also fed milk replacer with (n = 38) or without (n = 40) animal plasma to 29 d of age to determine the effect of plasma protein on IgG status, health and growth. Colostrum replacement was fed (Holsteins 1.89 L/feeding, Jerseys 1.42 L/feeding) at 1.0 and 13.0 h of age and provided a total of 250 (Holsteins) or 180 (Jerseys) g of IgG. Amount of pooled maternal colostrum fed (at 1.1 and 13.1 h) was adjusted to provide IgG equal to the replacement (Holsteins 249 g, Jerseys 186 g). Milk replacer (reconstituted to 12.5% DM) was fed at 10% of birth weight (2 feedings/d). Jugular blood was sampled at 0 h, 24 h, and weekly to determine plasma IgG. At blood collection calves were also weighed and measured to determine growth performance. Health scores, fecal scores, and grain intake were measured daily. Mean plasma IgG at 24 h did not differ between calves fed colostrum (13.78 ± 0.39 g/L) and replacement (13.96 ± 0.38 g/L). Plasma IgG and performance were not affected by addition of animal plasma to milk replacer. The colostrum substitute successfully replaced colostrum as the source of IgG for newborn calves. Animal plasma was an acceptable source of protein, but did not enhance growth or immunity.

Key Words: Colostrum Replacement, Immunoglobulin G, Animal Plasma

1100 Growth characteristics of replacement heifers in selected high producing Wisconsin dairy herds. N.C. Dorshorst^{*1}, H.A. Lonning², P.C. Hoffman¹, K.A. Weigel¹, and C. Dechow¹, ¹University of Wisconsin-Madison, ²University of Wisconsin-River Falls.

A field survey was conducted to assess growth characteristics of dairy replacement heifers in selected high producing Wisconsin dairy herds. From a pool (n=35) of Wisconsin dairy herds with herd milk production > 13,500 kg/lactation, twenty herds were randomly selected. The project involved collection of herd production data, a management survey, physical measurement of all calves and replacement heifers, and identification of sires for all calves and heifers for each herd. Physical measurements included estimation of weight via heart girth, wither height, body length, and body condition score. Statistics were compiled for herd inventories, milk production, and age at first calving. Physical measurements of heifers from all herds were compiled and summarized by month of age. Pre- and post pubertal growth of heifers for each farm were estimated using first order regression techniques. A summary of project results is as follows. Age at first calving in the selected herds was 25.9 ± 1.5 months and replacement heifers calved at an estimated pre-calving weight of 666 ± 60 kg. Regression estimated pre- and postpubertal growth rates of replacement heifers in the selected herds was 887 ± 120 and 741 ± 96 g/d, respectively. Estimated prepubertal growth rates ranged from 758 to 1243 g/d. Growth characteristics of Holstein calves and replacement heifers in the selected herds were similar to guidelines published in the literature. Survey data indicated that use of 3 x milking and rBST on both multiparous and primiparous cows was high at 77.8, 83.3, and 72.2%, respectively. Selected herds fed calves starter later, forage earlier than recommended guidelines and weaned calves using age criteria. Selected herds bred heifers using age (83.3%) more so than weight (16.7%) criteria. Data suggest replacement heifers on selected high producing dairy herds were older and heavier at first calving as compared to recommended guidelines. The influence of genetic selection on these data is yet to be determined.

Key Words: Heifers, Growth, Dairy

1101 Comparison of Lactational Response of Dairy Cows in Georgia and Israel to Heat Load and Photoperiod. Y. Aharoni¹, O. Ravagnolo², and I. Misztal², ¹Department of Beef Cattle, Agricultural Research Organization, Neve Yaar Research Center, Israel, ²Animal and dairy Science Department, University of Georgia, Athens 30605.

The seasonal effects of heat load (HL) and photoperiod (PP) during the lactation on milk yield and composition of primiparous cows were studied using test day records that were collected over an 8-year period 1990 through 1997 from 8968 cows in 76 farms in Georgia. The effect of prepartum PP on milk production in the subsequent lactation was also evaluated for these cows. These effects were tested in a regression model that accounted for a 4th order polynomial of days in milk (DIM) and fixed effects of year and farm in addition to the seasonal effects. The seasonal effects estimated for this database were compared with those estimated previously (Aharoni et al., 2000) for multiparous cows in Israel. The PP effect accounted for a difference of 2.7 kg/d of milk, 3.3 g/kg fat and 1.9 g/kg of protein in milk between peak and trough dates of the year, with peak dates at 5/02, 1/27 and 1/13 for milk yield and fat and protein contents in milk, respectively. The HL during the lactation had negative effects on milk yield and contents. The day length during the prepartum period had also negative effects on milk yield and contents. Most of the effects were highly ($P < 0.001$) significant. The match between the combined effect of HL and PP during the lactation in Georgia and Israel yielded r^2 values 0.978 and 0.984 for effects on milk yield and protein content, respectively, and $r^2 = 0.516$ for the effect on fat content. The effect of prepartum PP was similar in dates, but higher in Israel than in Georgia. This study indicated that the effects of both HL and PP during the lactation on milk yield and composition of primiparous cows in Georgia are very similar to these effects on multiparous cows in Israel. The mismatch of estimations on fat content could be explained by seasonal dietary changes due to a grazing season in Georgia, which is absent from the Israeli management. The difference in response to prepartum PP could be explained as the difference between heifers before their first calving in Georgia, and mature cows in Israel.

Key Words: Photoperiod, Heat Load, Milk Production

1102 Seasonal variation in the composition of milk from New Zealand Friesian and US Holstein dairy cows: impact of nutrition. M.J. Auldust*, A.R. Napper, and E.S. Kolver, Dexcel Ltd. (formerly Dairying Research Corporation Ltd.), Hamilton, New Zealand.

The manufacturing efficiency of dairy products is significantly limited by the seasonal variation in milk composition from pasture-based, seasonally calving dairying systems. This study tested the hypothesis that seasonal variation in milk composition is caused by changes in pasture composition and availability. Variation in milk composition was measured in 20 NZ Holstein-Friesian (NZHF) and 20 Northern Hemisphere Holstein-Friesian (NHHF) dairy cows grazing pasture or fed a total mixed ration (TMR). The study was conducted over two lactations, with samples of daily milk collected on 7 evenly-spaced occasions during Year 1 and 5 occasions in Year 2. In both years, NHHF cows produced more milk with lower concentrations of the major milk solids fat and protein, but higher concentrations of lactose than NZHF cows. Diet also affected concentrations of some major milk components. Detailed milk composition was generally unaffected by both genotype and diet. Feeding TMR for the entire lactation reduced seasonal variation in both years for lactose concentration, and in Year 1 for milk yield, fat, casein number, urea and Na. Overall, however, the reduction in seasonal variation due to TMR, if any, was minimal. The pattern of change in milk composition as the season progressed was similar for all treatment groups and could not be explained by diet. It is concluded that improved nutrition of grazing dairy cows would not significantly reduce seasonal variation in milk yield and composition.

Year	NZHF Grass		NZHF TMR		NHHF Grass		NHHF TMR		P A1	
	1	2	1	2	1	2	1	2	1	2
Yield	3.62	5.32	2.42	4.79	4.43	5.80	2.64	5.81	**	NS
Fat	3.91	5.54	5.25	5.64	4.24	4.68	5.63	5.64	**	NS
Protein	2.42	2.62	1.94	3.07	2.48	2.02	1.69	2.89	NS	*
Casein	2.06	1.92	1.69	2.37	1.98	1.52	1.54	2.24	NS	*
Lactose	1.38	2.08	0.71	1.46	1.46	1.85	0.73	1.16	**	**
Casein										
No.	0.020	0.011	0.018	0.010	0.023	0.011	0.015	0.010	**	NS
BSA	33.9	41.3	23.9	44.2	33.9	38.7	32.6	43.7	NS	NS
Urea	1.69	1.02	1.27	0.83	1.97	1.26	1.41	1.18	**	NS
Na	2.3	7.7	8.2	8.2	10.3	8.3	10.8	7.8	NS	NS

Data are standard deviations across the season - NOT absolute values ¹ Significance of diet effects on variation (no significant genotype effects); ** $P < 0.01$; * $P < 0.05$; N.S. = not significant

Key Words: Milk composition, Seasonal variation, Pasture

1103 Milk and meat samples obtained in Illinois contain variable amounts of conjugated linoleic acid. A.D. Beaulieu* and J.K. Drackley, University of Illinois, Urbana .

The objective of this study was to determine the mean content and variability of conjugated linoleic acid (CLA) in Illinois meat and milk. Samples of whole milk were obtained from 30 grocery stores over a one-year period and from 5 to 6 farms (bulk tank samples) in three geographic locations at three-month intervals for one year. Producers supplied feeding and management records. Eight cuts of meat were purchased from 24 stores at six-month intervals for one year. Sites were selected for sampling based on population density. Store milk contained a mean CLA content of 0.53 ± 0.02 (mg/100 mg fatty acids (FA) mean ± SEM) with a range of 0.43 to 0.81 mg/100 mg FA. The CLA content of milk obtained from producers averaged 0.53 ± 0.21 mg/100 mg FA with a range of 0.29 to 1.63 mg/100 mg FA. The highest value was from the only producer reporting 100% grazing. Complete or partial grazing increased ($P < 0.05$) CLA content of milk fat. Season, state location, breed, and fat supplementation did not affect ($P > 0.05$) CLA content of milk fat. The CLA content of milk fat was positively correlated ($P < 0.05$) with the C18:1_{cis-9} and the C18:1_{trans} content of milk fat and total milk production (kg/d) and negatively correlated ($P < 0.05$) with milk fat and milk protein percent. The following table presents the mean CLA content of the meat samples (lean tissue unless specified otherwise). The content of CLA in meat samples was similar ($P > 0.05$) among stores. The variable CLA content of milk and meat hinders the accurate estimation of CLA intake by a population. However, identifying the source of this variability will assist the development of CLA-enriched milk and meat.

Sample	CLA (mg/100 mg FA)			
	Mean ¹	Season		P-value Season
		March	August	
Ground beef	0.57 ^a	0.53	0.61	0.0023
Beef roast	0.46 ^b	0.36	0.55	0.0014
T-bone steak	0.41 ^c	0.34	0.48	0.0001
Turkey skin	0.22 ^c	0.20	0.23	0.4255
Turkey	0.20 ^d	0.21	0.19	0.4253
Chicken	0.15 ^e	0.19	0.10	0.0032
Pork chop	0.14 ^e	0.12	0.17	0.1028
Chicken skin	0.09 ^f	0.07	0.11	0.1441

¹SEM = 0.02, n = 24. ^{a,b,c,d,e,f} Values within a column are significantly different ($P < 0.05$).

Key Words: Conjugated linoleic acid, milk, meat

1104 Relationship of milk urea nitrogen and DHIA production variables in western commercial dairy herds. R.G. Johnson*, J.L. Walters, and A.J. Young, Utah State University, Logan, Utah.

Studies have shown relationships between milk urea nitrogen (MUN) and milk production levels in eastern and central North America. Feeding and management are different under western conditions and standard MUN concentrations are not known. Because MUN concentration has been associated with nitrogen utilization efficiency, it could become a useful management tool for dairy producers. The objective of this

study was to evaluate the relationship of MUN values with DHIA production values in commercial dairy herds in Utah and Idaho. Individual cow monthly test records (approximately 25,000) from 37 Holstein and 4 Jersey herds were analyzed. Records spanned two consecutive years ending December 2000. Mean test day milk yield per cow for all animals was 31.9 kg. Overall mean MUN was 14.88 mg/dl. Two statistical models were developed using the General Linear Model procedure of SAS. One model with MUN as the dependent variable had an r-squared of 0.27. Significantly related independent variables were: parity and somatic cell count (both linear); milk per cow, milk protein %, milk fat %, days in milk and month of year (cubic). When milk per cow was the dependent variable the r-squared was 0.51. Significantly related independent variables were: milk fat %, parity, MUN, milk protein %, somatic cell count, days in milk and month of year (all cubic). There were differences between cows of the Holstein and Jersey breeds with respect to MUN and season. Holstein MUN was highest in winter, while Jersey MUN was highest in summer. There was no significant breed difference in mean MUN. Our data show that MUN is associated with DHIA production variables and can be used to develop optimal MUN concentrations unique to western dairies.

Key Words: MUN, DHIA

1105 Stochastic modeling of different approaches to dairy cattle reproductive management. M.W. Overton*, U.C. Davis- *Veterinary Medicine Teaching and Research Center.*

A stochastic simulation model was used to compare potential economic returns of three popular synchronization programs, Ovsynch, Presynch, and Modified Presynch, as compared to a traditional breeding program based on artificial insemination following heat detection. The model applied these programs early in the breeding period, followed by traditional breeding for the remaining cycles. Interventions were modeled using a combination of decision tree analysis, partial budgeting, stochastic simulation modeling, and economic sensitivity analysis. Herd specific inputs included voluntary wait period, drug costs, breeding expenses, and labor costs. Conception rate, heat detection rate, and rolling herd average were input as distributions rather than discrete probabilities. Data from over 100 conveniently sampled California dairy herds was used to fit the specific distributions. Conception rate and heat detection rate changes over the breeding period were modeled by applying correction factors to the original distributions. Pregnancy rate results predicted for each cycle were then used to project cumulative pregnancy rate over 10 breeding cycles. Results were obtained by running 5000 iterations through the use of simulation software and are displayed as probability distributions, with a mean and standard deviation. The model predicted that implementation of any of the three breeding programs early in the breeding period would improve pregnancy rate during the modeled cycle and throughout the balance of the breeding program. Predicted economic returns, using modifications of the Woods equation, were greater for each of the interventions as compared to traditional breeding utilizing current levels of heat detection and conception rate.

Key Words: Dairy, Reproduction, Stochastic Modeling

1106 Changes in rumen temperature, vaginal temperature and drinking behaviour throughout the estrous cycle in dairy cows. A. D. Kennedy* and S. R. Mathew, *University of Manitoba.*

Four first calf Holstein dairy heifers (71 to 161 d postpartum) fitted with rumen cannulae were monitored continuously for 66 d. Temperature radiotransmitters were situated in both the rumen and vagina and temperature values were recorded every 4 minutes. Heifers were synchronized twice using the Ovsynch program with the first GnRH injections given on days 9 and 53 such that there were two induced ovulations and one natural ovulation expected during the study. Milk progesterone analysis indicated 13 periods of corpus luteum (CL) regression but temperature values were available for only 8 (vaginal) and 7 (rumen) of these occasions. Vaginal and rumen temperature peaks were found during 8 of 8 and 5 of 7, respectively, periods of CL regression. Rumen temperature was highly variable and a number of peaks were observed when the CL was not regressed (26 false positives). Reduced drinking behaviour was found on the day of estrus suggesting that peaks in rumen temperature reflect reduced water intake.

Key Words: Temperature, Vaginal, Rumen

1107 Follicular growth in lactating cows receiving recombinant bovine somatotropin, gonadotropin releasing hormone, and prostaglandins: contrasts between winter and summer months. Z Keister*, R Collier, and R Ax, *University of Arizona, Tucson, AZ/USA.*

Three experiments were conducted with Holstein (n = 72) and Brown Swiss (n = 73) cows beginning 56 ± 3.5 d postpartum to determine ovulation rates in a thermal stress arid climate over three consecutive seasons (Summer, 1999; Winter, 1999-2000; and Summer, 2000). All cows received recombinant bovine somatotropin (rbST) beginning d 63 ± 3.5 postpartum regardless of treatment. For Exp.1, 58 cows were assigned at calving, beginning June 1, 1999, to either a cooled (Korral Kool#) or non-cooled (shade only, control) pen. At d 56 ± 3.5 postpartum, all cows commenced a hormonal program coined Select Synch, comprised of an injection of gonadotropin releasing hormones (GnRH, 100 micrograms) agonist (Factrel#) followed 7 d later with an injection of prostaglandin (25 mg In-Synch#), at which time ultrasonography was initiated and continued until ovulation or follicular turnover. Exp. 2 was the same as Exp. 1, with assignment of cows starting Nov. 1, 1999. In Exp.3, all cows were assigned the same as Exp. 1 and 2 beginning June 1, 2000. At d 56 ± 3.5 postpartum, cows were scheduled to commence Ovsynch, which was identical to Select Synch, except a second Factrel# injection was administered 33 h after 35 mg Lutalyse#. Ovsynch was more effective at causing subsequent ovulations for the non-cooled and cooled cows (77.3 and 69.6%, respectively), than Select Synch for the non-cooled, cooled, and winter treatments (27.6, 24.1 and 29.4 %, respectively). In conclusion, ovulation outcome was related to hormonal programming rather than season.

Key Words: Follicle growth, GnRH, prostaglandin

1108 The relationship of indicators of thermal balance and milk production of cows on Missouri dairy farms. James Spain*¹, Julie Sampson¹, and Don Spiers¹, ¹*University of Missouri.*

Three dairy farms cooperated in conducting an on farm experiment to evaluate heat stress of dairy cattle. The farms were located in Missouri in Bates, Callaway, and Franklin counties. All three farms used Holsteins housed in free stall housing systems. Farms provided cows with total mixed diets unique to the specific farm. All three farms milked twice daily (0400 to 0800 and 1600 to 2000). Lactating dairy cows were selected on each farm to create uniform groups of cows across the farms. Selected sentinel cows were housed together within larger groups of cows. Milk yield was measured and recorded on each cow at each milking during the experiment. Respiration rate, rectal and skin temperatures were measured for each cow three days a week (Monday, Wednesday and Friday) and three times per day (0800, 1400 and 2000 hours). Skin temperatures were measured at three different locations (tail head, rump and shoulder). Animal thermal balance indicators were regressed with milk production to identify those factors affecting milk yield. On Farm A, two barns were used with primiparous cows and multiparous cows housed separately. Regression analysis found a strong and significant relationship between animal thermal balance and milk yield on all three farms. On Farm A, the shoulder and rump skin temps at 0800, shoulder and rump temps at 1400, and tailhead skin temps at 2000 were related to milk yield (R²=.72). In comparison, the primiparous cows included all skin temps and rectal temp recorded at 0800, shoulder and tail skin temps at 1400, rectal and shoulder temps at 2000 as well as respiration rates at 1400 and 2000 (r²=.61). Milk production of cows on Farm B was related to Respiration rate at 0800 and 2000, Rump temp at 0800 and 1400, shoulder skin temps at 1400 and 2000 and rectal temps at 0800. Cows on Farm C had milk production related to the 0800 rectal, rump skin, and tail skin temps, 0800 rectal temp, rump and shoulder skin temps at 1400 and 2000 and respiration rates at 0800 and 1400. The 1400 and 2000 measurements were less consistent in predicting milk yield. Early morning measurements were consistently and strongly related to milk yield indicating night time environmental conditions strongly affect the cows thermal balance and milk yield.

Key Words: Heat Stress, Thermal Balance, Milk Production

1109 Effect of feeding of yeast to crossbred calves. DilipKumar Garikipati*¹, Sarjan Rao Kapa¹, Rajasekar K², and Kailash MM³, ¹College of Veterinary Science, Tirupati, ²College of Veterinary Science, Hyderabad, ³Bangalore Agricultural University.

Thirty eight HF crossbred calves of F2 generation (age= 1 day) were allotted to one of two dietary treatments. Calves were offered a commercial calf starter with (yeast) or without (control) 10g/Kg of commercial yeast ad libitum for 56 days. Calves were allocated to treatments over 40day period and were housed in individual calf hutches. Calves were fed 4L/day pasteurized milk in 3 equal feedings. Calves starter (yeast and control) were offered ad libitum starting day 2 until day 56. Calves were weaned when they consume 800g of calf starter for 3 consecutive days. Body weight of calves was recorded at entry, weaning 4 at (BW) 56 days. Data were analysed as a completely randomized design using ANOVA procedures. Three calves one from control and two from yeast were removed due to health problems. Calves fed control were weaned earlier (51.8 Vs 55.2, p<00.2) as compared to calves fed yeast. Inclusion of calf starter reduced 56 day starter in take (23.9 Vs 30.6 kg, p<00.4). There were no differences in BW at weaning, BW at 56d, average daily gains or feed efficiency between calves fed control or yeast. Data suggest yeast culture inclusion in calf starter decreased starter in take and increased weaning age.

item	control	yeast	S.E	P<
Begin BW, kg	28.4	28.8	.97	.39
Weaning age, d	51.8	55.2	1.21	.05
Weaning BW, kg	45.8	47.2	1.07	.67
56d BW, kg	47.1	46.1	1.82	.12
56d ADG, g/d	334	321	24.8	.38
Starter in take, kg	30.6	23.9	2.43	.04

Item Control Yeast S.E P< Begin BW, kg 28.4 28.8 .97 .39 Weaning age, d 51.8 55.2 1.21 .05 Weaning BW, kg 45.8 47.2 1.07 .67 56d BW, kg 47.1 46.1 1.82 .12 56d ADG, g/d 334 321 24.8 .38 Starter in take, kg 30.6 23.9 2.43 .04

Key Words: yeast, calves, starter

1110 The response of a non-medicated replacer containing a mannanoligosaccharide on growth and health parameters in neonatal dairy calves. A. J. Heinrichs*, M. R. Long, and T. S. Schriefer, *The Pennsylvania State University, University Park, PA.*

The objective of this experiment was to study the effectiveness of a non-medicated milk replacer containing a mannanoligosaccharide (BioMos, Alltech, Inc) on growth and health in dairy calves. Seventy-two Holstein calves (heifers and bulls) were used to evaluate a 20% CP 20% fat milk replacer with either Neo-Terramycin (400gms/ton Neomycin + 200 gms/ton Oxytetracycline; NT), mannanoligosaccharide (4 g/hd/day; MO) or no additions (C) in a randomized block design. The replacer was mixed at 10 oz./2 quarts of water and fed at a rate of 12 percent of birthweight/day through the end of the first week of age and then increased to 14% of birthweight until weaning at 35 d. Calves had a significantly higher probability (P < .01) of normal fecal scores including consistency, color, and severity of scours, with both the NT and MO treatments. Treatment of clinical scours occurred on 5 calves on C, 3 on NT, and 2 on MO. The rate of feed intake increase as determined by week of age, was significantly greater (P < .05) for the MO treatment over the NT treatment. There were no significant differences in any weight gain or structural growth at the conclusion of the study. Total blood protein levels were not different for any treatments; values were 5.3, 5.3, and 5.4 mg/ml for C, NT, and MO treatments respectively. Blood urea nitrogen values were 10.0, 10.4, and 10.0 mg/dl for C, NT, and MO treatments, respectively. The addition of a mannanoligosaccharide improved fecal scores in a similar or slightly better manner than did the NT treatments over the C calves in this study. Feed intake was improved in the calves fed the MO over the NT treatment, however this increased feed intake was not great enough or for an extended period of time to cause any differences in body weight during the 6 weeks of this study. The NT treatment appeared to improve feed efficiency at the end of the study. The addition of a mannanoligosaccharide in the milk replacer appeared to be beneficial to reducing scours in the calves and promoted greater feed intake.

Key Words: Dairy calves, Growth, Milk replacer

1111 Evaluation of spray dried animal plasma addition to milk replacer fed to calves at 2 feeding rates. D. R. Catherman*, *Strauss Feeds, Watertown, WI.*

Eighty-five Holstein heifer calves (average 37.9 kg BW) were used to evaluate the addition of 5% spray dried animal plasma (AP) to milk replacer (MR) compared to all milk proteins (AM) when fed a two feeding rates. Calves were allotted by weight to one of four treatment groups and fed as follows: treatment 1, AM fed at 454 g/d; treatment 2, AP fed at 454 g/d; treatment 3, AM fed at 681g/d and treatment 4, AP fed at 681 g/d. All treatments were formulated at 22% protein and 20% fat and fed in a volume of 3.8 l/d. Calves were weaned at 35 d and feed intake was recorded for 42 d. Calves were weighed at 0, 21 and 42 d. Water and starter grain (18% protein) were offered free choice from d 3. Total MR intakes were 13.5, 13.5, 18.0 and 18.0 kg for treatments 1 through 4, respectively. Total starter intakes were numerically higher for treatments 1 (37.4 kg) and 2 (38.3 kg) than for treatments 3 (34.6 kg) and 4 (36.1 kg). Weight gains between d 0 and 21 were lower (P<.05) for treatments 1 (10.0 kg) and 2 (10.0 kg) than for treatments 3 (12.2 kg) and 4 (12.3 kg). Between d 21 and 42, weight gains were higher (P<.05) for treatments 1 (12.4 kg) and 2 (13.6 kg) than for treatments 3 (11.8 kg) and 4 (11.3 kg). Overall weight gains (d 0 to 42) were not different. Feed cost per kg of gain was not different, but tended to be lower for treatments 1 (\$1.36) and 2 (\$1.28) than for treatments 3 and 4 (\$1.52). Scour scores were not different. Medication costs tended to be lower in treatments containing AP (\$10.49, \$9.96, \$10.18 and \$9.32 per calf for treatments 1 through 4, respectively). These data indicate AP offers an acceptable alternative to whey proteins in milk replacer formulations at 5% inclusion rate. Feeding rate did not impact the acceptability of AP. Inclusion of AP may have influenced the overall health of the calves based on medication costs, although more data will be required to confirm this tendency.

Key Words: calves, milk replacer, animal plasma

1112 Effects of Supplemental Vitamin E and Lasalocid on Disease Severity and Immune Responses of Calves Challenged With *Eimeria bovis*. G. E. Goodier*¹, C. C. Williams¹, K. L. O'Reilly², T. G. Snider², J. C. Williams¹, H. G. Bateman, II¹, D. T. Gantt¹, and C. M. Cheatham¹, ¹LSU Agricultural Center, Baton Rouge, LA, ²LSU School of Veterinary Medicine, Baton Rouge, LA.

Thirty-two male Holstein calves were utilized in a completely randomized design with a 2x2 factorial arrangement of treatments to investigate the use of Vitamin E (Vit E) alone or in combination with lasalocid (LAS) in the control of coccidiosis. Coccidiosis was experimentally induced using an oral dose of 100,000 *E. bovis* oocysts when calves were 2 wk of age. Calves received colostrum (COL) for the first feeding and then the colostrum supplement Lifeline® (LL) (American Protein Corporation) at the second feeding. All calves were fed milk replacer (MR) containing 20 IU Vit E/lb at 10% of birth weight. At wk 4, MR was reduced 50% and calves abruptly weaned at wk 5. Vit E treated calves (n=16) were given 180 IU Vit E (Roche Vitamins, Inc.) in the MR once daily and then orally drenched after weaning. LAS treated calves (n=16) were given LAS (Roche) at 1mg/kg of body weight in both MR and starter. Fecal scores were recorded twice daily, and body weights were recorded weekly through the 8 wk study. Blood samples were collected and analyzed for whole blood IgG (Midland BioProducts) before the LL feeding and 24 hours later. Blood and saliva were collected from each calf at 24 hrs and 2, 4, 6, and 8 wk of life to determine levels of total Igs, IgG₁, IgM, and IgA. Four calves from each study were killed at wk 8 for examination of grossly visible intestinal lesions. Whole blood IgG revealed 14 calves failed to receive adequate Igs from COL or LL, but these results had no effect on calf performance. Calves fed LAS had higher (P = 0.06) levels of total Igs from wk 3 until the end of the study. Control (C) calves had lower IgM levels throughout the study (P > 0.05), and calves fed Vit E alone had increased levels of IgM at wk 6 and 8 (P < 0.05). No differences in IgG₁ and IgA levels were observed between treatment groups (P > 0.05). Prevalence and severity of infections were greater in C and Vit E calves compared to those fed LAS. Post mortem analysis revealed that by wk 8 no intestinal lesions were present, indicating recovery from the disease. While supplemental Vit E alone did not improve calf performance, LAS was effective in decreasing severity of coccidiosis in this study.

Key Words: Coccidia, Lasalocid, Vitamin E

1113 Effect of monensin, lasalocid, and decoquinatone on growth, feed intake, and feed efficiency of dairy heifers. D.G. Schmidt^{*1}, J.E. Shirley¹, E.C. Titgemeyer¹, M.V. Scheffel¹, and E.E. Thomas², ¹Kansas State University, Manhattan., ²Elanco Animal Health, Greenfield, IN.

One hundred eighty Holstein heifers were used in a randomized block design to evaluate response to starter diets containing decoquinatone (D), monensin (M), or lasalocid (L) and the benefits of ionophores in grower diets during the transition from individual hutches to group pens. Treatments (90% air dry basis) for the first eight weeks of age (Phase 1) were M (33 mg/kg), L (83 mg/kg), or D (33 mg/kg). Heifers within each Phase 1 treatment group were ranked by weight and alternately assigned to either M or L and housed in pens containing 5 heifers each during an 84-d growing period (Phase 2). During Phase 2, heifers were fed only a grain mix containing M (31 mg/kg) or L (31 mg/kg) for the first 14 d, then a grain mix with chopped alfalfa hay during the second 14 d and a TMR the last 56 d. Diets were fed during the first 28 d to allow ad libitum intake (5% orts). Ionophores were delivered (100 mg/heifer daily) with the TMR as a top dress with finely ground corn. No difference in daily gain, feed intake, feed efficiency, or body weight gain was observed among treatments during Phase 1. Heifers fed ML gained slower during the 84-d growing period (Phase 2) than heifers fed the other treatments ($P < 0.05$). Heifers fed D (Phase 1) performed similarly when switched to M or L. Heifers switched from L to M performed similarly to heifers fed LL or MM. Results of this study suggest that heifers fed D or L prior to weaning can be successfully switched to M during the growing phase, but heifers fed M prior to weaning will not perform as well if they are switched to L during the growing phase.

Treatment Schemes¹

Phase 1	D		L		M	
No. of Heifers	60		60		60	
Phase 2	L	M	L	M	L	M
No. of Heifers	30	30	30	30	30	30
No. of Pens	6	6	6	6	6	6
Treatment	DL	DM	LL	LM	ML	MM

¹D = decoquinatone, L = lasalocid, M = monensin.

Key Words: Dairy heifer, Ionophores, Decoquinatone

1114 Effect of rearing methods of dairy-heifers prior to weaning on growth and reproduction. Jan J.J. Broucek^{*1}, Clive W. Arave², Ted H. Friend³, Stefan Mihina¹, Michael Uhrincat¹, Anton Hanus¹, Stefan Marencak¹, and Peter Kisac, ¹Research Institute of Animal Production, Nitra, Slovakia, ²Utah State University, Logan, USA, ³Texas A&M University, College Station, USA.

Holstein heifer calves (n = 92) were assigned to one of five rearing treatments after having nursed their dams for 24 h: A) individual hutches until 7 d of age followed by group housing with a machine milk feeder until weaning at 8 weeks; D) penned with dam until 7 d of age followed by group housing with a machine milk feeder until weaning; H) individual hutches until weaning; M) penned with dam for the first 7 d followed by an individual hutch until weaning; N) penned with dam for the first 7 d followed by penning with a nursing cow until weaning. Animals of all groups were kept after weaning in age-balanced groups in bedded pens with the same balanced ration. Parturition was classified according to a point system, i.e. 1) - no help, 2) - assisted by one person, 3) - assisted by 2 to 3 persons, a small injury of the genital tract, 4) - difficult parturition. Live body weight at the birth was not significantly different. At 180 d of age, statistically significant differences $P < .05$ were found in weight gains between N, D and A, and between H and A. The ranking of animals was: N (.79 kg), H (.74 kg), M (.71 kg), D (.68 kg), A (.64 kg). A slightly increased growth in live body weight in the groups N, M and H continued until the age of 630 days. The order of groups according to the average live body weight at 21 months was: N (491 kg), H (486.5 kg), M (481.6 kg), A (477 kg), D (468 kg). From the birth until the twenty-first month, the average daily weight gains were no significant: N (.71 kg), H (.71 kg), M (.70 kg), A (.69 kg), D (.67 kg). Conception ages (H=555 d, M=554.7 d, N=549 d, D=534.5 d, A=530.6 d) nor live body weights at day of conception (H=455.4 kg, N=449 kg, A=426.6 kg, M=426.5 kg, D=418 kg) were not significant. The most difficult calvings (not significantly) were in group M (2.4) and the easiest in group H (1.6). A significant difference ($P < .05$) was found in the birth weight of calves born to mothers in groups N (42.4 kg) and D (36.4 kg). The

results show that the rearing conditions had little long-term effect on the variables measured.

Key Words: Dairy cattle, Rearing, Growth

1115 Prediction and ranking of first lactation milk production using parents' predicted transmitting abilities. B. R. Radke^{*1}, J. W. Lloyd², J. B. Kaneene², J. R. Black², and S. Harsh², ¹Alberta Agriculture, Food and Rural Development, Edmonton, AB, ²Michigan State University, East Lansing, MI.

Decreased culling rates can increase the net income of dairy producers by increasing cow longevity. To decrease the culling rate, the replacement rate must also be reduced, necessitating a method of prepartum heifer selection. First lactation milk production is a proxy for dairy cow profitability and is a suitable heifer selection objective. The objectives of this study included determining: 1) the ability of parents' predicted transmitting abilities (PTAs) for milk, fat and protein to predict daughters' subsequent first lactation milk production; 2) the ability of the predictions of first lactation milk production to correctly rank heifers within herd based on actual milk production; and 3) whether, in estimating this linear relationship, the herd effect needed to be estimated as a fixed effect. The data consisted of first lactation mature equivalent milk production of 5,123 Michigan Holstein heifers from 576 herds, and the heifers' parents' animal model evaluations immediately prior to the heifers' calvings. The heifers were born in the last six months of 1992 and calved in the last six months of 1994. Linear regression of parents' PTAs on daughters' subsequent first lactation milk production resulted in $R^2 = 0.068$ and $R^2 = 0.067$ when herd was estimated as a random and fixed effect, respectively. The distribution of within herd Spearman rank correlations between the predicted mature equivalent milk production (based on parents' PTAs) and the actual mature equivalent milk production was diffuse, skewed to the left, and had a median of 0.25 with 65% of the herds having a positive rank correlation. This suggested the PTAs had some ability to correctly rank the prepartum heifers' subsequent first lactation milk production, and therefore may be useful in prepartum heifer selection. Treating herd as a fixed or random effect resulted in statistically different ($P < 0.0001$) models. However, the predictions from the two models had Spearman rank correlations greater than 0.90 for 96% of the herds suggesting that in practical terms, it is unclear whether herd needs to be estimated as a fixed effect.

Key Words: Prediction First Lactation Production, Random Effect, Fixed Effect

1116 Effect of wheat variety and replacing wheat with maize grain on feed intake and milk production of Holstein dairy cows. R.H. Phipps^{*}, J.D. Sutton, and A.K. Jones, *The University of Reading, Reading, UK.*

Fifteen multiparous cows were used in a 5 x 5 latin square trial with five, four-week periods. Cows were offered ad libitum a forage mixture of maize silage (368 g DM/kg, 308, 329 and 85 g/kg DM, starch, NDF and CP) and grass silage (325 g DM/kg, 496 and 132 g/kg DM, NDF and CP) in a 3:1 DM ratio. Cows received 12kg/d fresh weight (fwt) of one of five different concentrates (T1-T5), all of which contained 400 g/kg fwt of cereal grain. The nutritive value of concentrates was similar. In T1 and T2 wheat varieties Rialto (high viscosity) and Soissons (low viscosity) formed 100% of the cereal grain component. In T3, T4 and T5 maize grain replaced Rialto wheat to give the following proportions of wheat and maize grain, 62.5:37.5, 37.5:62.5 and 0:1. Feed intake and milk yields, for T1-T5 (respective means and s.e.d.) were 22.1, 21.5, 21.8, 22.3, and 22.2 (0.31) kg/d and 35.8, 36.3, 35.7, 36.6 and 37.4 (0.77) kg/d. The corresponding values for milk fat and protein contents were 37.1, 36.7, 35.9, 35.5 and 37.3 (1.64) g/kg and 31.7, 31.6, 31.7, 31.8 and 31.6 (0.29) g/kg. Yields of milk fat and protein for T1-T5 were 1326, 1330, 1279, 1285 and 1386 (60.6) g/d and 1128, 1142, 1126, 1157, and 1179 (25.5) g/d, respectively. Although feed intake for T1 was higher ($P < 0.05$) compared with T2, milk production was unaffected by wheat variety. Replacing Rialto wheat with maize grain did not affect feed intake but increased ($P < 0.05$) milk yield from 35.8 to 37.4 kg/d. Regression analysis showed a linear effect ($P < 0.05$) of increasing the proportion of maize grain in the concentrate (from 0 to 100% of cereal grain) on milk yield (1.7 kg/d 0.75) and protein yield (55 g/d 24.7). There were no effects on milk composition. Results indicate that increased supply of bypass starch through the use of maize grain could

increase milk production in UK dairy herds but a cost benefit analysis is required to determine its economic feasibility.

Key Words: Dairy cows, Milk production, Maize and wheat grain

1117 Evaluation of cow preference between modern and old free-stall design. R. J. Norell^{*1}, A. Ahmadzadeh², and E. P. Wagner², *University of Idaho*, ¹*Idaho Falls*, ²*Moscow*.

Cow preference was assessed between old and modern design freestalls. Two pens of 20 lactating Holstein cows were each provided 9 modern stalls (MOD) and 9 old stalls (OLD). MOD stalls were wider (1.22m vs 1.14m), had taller stall dividers (1.22m vs 0.91m), and had improved forward/sideways lunge space. OLD stall bases were deep sand over concrete blocks in pen 1 and deep sand over clay filled tires in pen 2. MOD stalls had sand over commercial rubber filled mattresses. Cow behavior was scanned every 15 minutes during a 7.5 h observation period on nine evenings (8PM to 3:30AM). Behavioral data were summarized by stall and analysed with a split plot in time ANOVA for each pen. For pen 1, LSM means and SE for %occupancy, %resting, %standing, and stall turnover rate were: 84.7 vs 78.2 ±2.8; 74.1 vs 67.0 ±2.3; 10.5 vs 11.1 ±0.9; 3.3 vs 3.9 ±0.2 for MOD and OLD, respectively. For pen 2, LSM means and SE for %occupancy, %resting, %standing, and stall turnover rate were: 90.5 vs 64.0 ±5.0; 82.2 vs 50.4 ±5.4; 8.3 vs 13.6 ±1.4; 3.2 vs 3.0 ±0.2 for MOD and OLD, respectively. Cows spent more time occupying MOD in pen 2 ($p < 0.006$) but not in pen 1. Cows spent more time resting in MOD stalls in both pen 1 ($p = 0.06$) and pen 2 ($p < 0.003$). Standing behavior was not different in pen 1 but was higher ($p < 0.03$) for OLD in pen 2. Stall turnover rates were similar between stall designs in both pens. We conclude that modern stalls with greater width, improved lunge space, and rubber filled mattress are preferred by lactating cows as evidenced by improved occupancy and resting behavior.

Key Words: Free-stalls, Cow Preference

1118 Whole-farm nitrogen efficiency and balance compared with the milk urea nitrogen test. R.A. Swain^{*1}, J.L. Walters¹, R.A. Kohn², and A.J. Young¹, ¹*Utah State University, Logan, UT*, ²*University of Maryland, College Park, MD*.

Environmental legislation has made it necessary for producers to be able to quantify and adjust the nitrogen (N) balance on their farms. Milk urea nitrogen (MUN) was evaluated as a practical means of evaluating whole-farm N balance. Forty-one commercial dairies in UT and ID were contacted and evaluated for whole-farm N balance using the University of Maryland Nutrient Balancer. Producers were interviewed in order to obtain annual amounts of purchased feed and fertilizer, crops grown and sold, cows purchased and sold, exported manure, pounds of milk sold, number of cows and heifers, and production characteristics such as milk protein and rolling herd average. MUN concentrations were collected from two consecutive DHIA tests. Freshly excreted and stored manure samples were collected. Individual whole-farm N balance and N utilization efficiency were determined. Whole farm N utilization efficiencies, based on MUN, were calculated using the models of Jonker et al. (J. Dairy Sci. 81:2681) and Kauffman and St. Pierre (J. Dairy Sci. 82 (Suppl. 1): 95). Herds ranged from 57-1960 cows, 6568-13863 kg of milk/cow, 9.5-20.5 mg/dl MUN, 12.6-36.2% N utilization efficiency, and 2.52-445.52 tonnes/yr potential N loss. A multiple regression model was run with whole-farm N balance (tonnes/yr) as the dependent variable. Significant independent variables were: number of cows, imported feed and fertilizer N, exported manure N, and herd N utilization ($r^2 = 0.98$). This suggests lower N balance on farms where all feed is imported. Herd N utilization had the single largest effect on N balance; an increase of 1.0 % resulted in a decrease of 1.88 tonnes/yr ($P < 0.0001$). Number of cows showed the smallest effect and did not affect N balance per unit of product produced ($P = 0.585$). The Jonker et al. ($r^2 = 0.15$, $r^2 = 0.19$) and Kauffman and St. Pierre ($r^2 = 0.12$, $r^2 = 0.10$) models were significant when regressed on herd N utilization and N balance, respectively. MUN may be a useful indicator of whole-farm N balance. Funded by SARE grant SW99-024.

Key Words: MUN, Whole farm nitrogen balance, Nitrogen efficiency

1119 Determining the relationships among milk urea nitrogen and milk production, milk protein, milk fat and somatic cell count from lactating cows in Texas. G.M. Goodall^{*1}, M.A. Tomaszewski¹, L.W. Greene², R.B. Schwartz¹, J.W. Stuth¹, and E.M. Sudweeks³, ¹*Texas A & M University, College Station, TX./USA*, ²*Texas A&M University Research and Extension Center, Amarillo, TX./USA*, ³*Texas A&M University Research and Extension, Overton, TX./USA*.

The objectives of this study were; 1) determine the relationship among Milk Urea Nitrogen (MUN) and milk production, milk protein, milk fat and somatic cell count, 2) determine economic consequences of reducing excessive milk urea nitrogen and phosphorus in the dairy cow diet. The potential impact was the development of a relationship among the components and MUN levels to alert producers of protein inefficiencies or excesses. Excessive protein has increased environmental nitrogen loading, increased feedcost, and resulted in adverse reproductive performance. Component pricing of milk has encouraged critical evaluation of milk records. This included the evaluation of the fat: protein ratio. The data was collected monthly over the course of 3 years. Over 20,000-cow testday records were collected including; calving interval, freshening date, days open, lactation number, longevity, days in milk, test day milk, milk components and their ratios, peak milk, MUN, and feeding program. The herd size varied from 110 cows to 852 cows. The feeding programs represented included Total Mixed Ration (TMR) fed herds and pasture-grazed herds. The economic evaluation objective looked at two main goals; 1) evaluation of the effect of milk urea nitrogen on longevity and milk production, and 2) calculation of decreased costs associated with decreased phosphorus levels. Previous TAMU extension demonstration data indicated a potential saving of \$14,000.00 per year for a 16% reduction in manure phosphorus in a 1000-cow herd. MUN levels were significantly affected by season, and feeding program. Peak milk production was significantly lower and MUN levels were significantly higher with the grazing herds. The data indicates the need to evaluate MUN levels based on feeding programs and season. Combining the MUN and component evaluation utilizes herd records for economic and environmental benefit.

Key Words: Dairy-cows, Environment-nitrogen and phosphorus, Monitoring-milk components, mun

1120 Comparing nutrient analysis of liquid dairy waste in storage versus field application. R. J. Norell^{*1}, S. C. Parkinson², and D. E. Falk³, *University of Idaho*, ¹*Idaho Falls*, ²*Preston*, ³*Twin Falls*.

Sampling of liquid dairy waste is necessary for reliable nutrient application rates to farm crops. The objective of this study was to compare sampling from storage versus sampling during land application. Three methods of land application were evaluated: (GRAVITY) liquid transport by gravity flow to gated pipe irrigation, (PUMP) pumping to gated pipe irrigation, and (TANK) pumping into a tractor drawn vacuum tank. Four pairs of samples were collected at each dairy. Each pair included a storage sample and a land application sample. Overall data were analyzed with a paired t-test ($n=48$ pairs). Mean storage concentration, mean difference (storage minus field) and SE of difference were: 0.99, 0.19±0.07; 0.48, 0.21±0.07; 506.0, 69.1±18.9; 91.2, 14.8±4.0; 39.5, -0.6±1.0; and 1272.6, -9.3±14.6 for (DM) % dry matter, (SS) % suspended solids, (TKN) ppm total kjeldahl nitrogen, (P) ppm total phosphorus, (OP) ppm ortho-phosphorus, and (K) ppm potassium, respectively. DM, SS, TKN, and P were significantly higher in storage samples ($p < 0.005$) but OP and K were not different between storage and field sample pairs. Mean differences in SS, P, and K were larger for TANK ($p < 0.05$) than in GRAVITY and PUMP sample pairs. Sampling liquid waste at the storage facility appears to overestimate the amount of nutrients actually applied to field crops.

Key Words: Dairy waste, Nutrient concentration, Sampling technique

1121 Utility of body condition score (BCS) system in relation to the physical and production parameters in crossbred cows. Dilipkumar Garikipati^{*1}, Sarjanrao Kapa¹, and Kailash MM², ¹*College of veterinary science, Tirupati, ANGRAU*, ²*University of Agricultural science, Bangalore*.

Body condition score (BCS) system is a subjective scoring method of evaluating the energy reserves of dairy cows which provide the better

reporting, via radio signals, of the GPS positional locations to an on-site computer. In addition to the animal GPS units, fixed GPS units were located at known locations within the pastures for additional data correction factors. In the summer of 2000, 16 crossbred steers were used to test the units and collect initial data. Data points were collected and transmitted to the on-site computer at one-minute intervals for a period of 28 hours, with 3108 data points collected on two steers. Battery life is affected by the data transmission interval, which may be set over a range of 10 second to 40 minute intervals. Costs for the cattle tracking GPS system, excluding labor for fabrication, were \$1000-\$1500 for the animal units (depending on the type of battery used), \$1300 for the DGPS base station, \$500 for the GPS position receiving base station, \$700 for fixed location GPS units, and the cost of a computer to download the data. This system allows for real-time monitoring of cattle grazing pastures at a lower price than commercially available units and should be useful for a wide variety of applications.

Key Words: GPS, Cattle, Grazing

1126 Effects of liquid supplement pH and acid source on liquid supplement intake of beef heifers and gestating beef cows. P.A. Davis¹, W.E. Kunkle¹, and J.D. Arthington², ¹University of Florida, Gainesville, ²UF-IFAS Range Cattle Research and Education Center, Ona, FL.

Effects of lowering pH of sugarcane molasses-based liquid supplements (MOL) on ad libitum supplement intake were evaluated in two experiments. For Exp.1, four treatments were a 16% crude protein MOL, pH 4.2 (T4.2) and T4.2 acidified to pH 3.4 (T3.4), 2.9 (T2.9), and 2.3 (T2.3) using feed grade phosphoric acid added at 3, 6 and 9%, respectively. Intakes of these supplements were compared using a 4 x 4 Latin square design with five crossbred beef heifers (273 to 386 kg initial BW) in each of four 1.8 ha bahiagrass pastures. Each treatment was offered ad libitum in 288 kg capacity tanks with one lick wheel. Each period of the Latin square was three wk long and MOL consumption was measured weekly. This 84 d experiment was conducted twice, at Gainesville (GNV) and Ona (ONA) locations, during Summer 2000. In Exp. 2, seven treatments included T4.2 and T4.2 lowered to pH 3.25 with hydrochloric (C), phosphoric (P) or sulfuric (S) acids creating treatments C3, P3 and S3, respectively; and to pH 2.30 with C, P and S creating treatments C2, P2 and S2. Seventy Angus beef cows (560 kg BW) were assigned randomly to 14 bahiagrass pastures divided into two replicates in a complete block design. Supplement consumed was measured weekly during an initial three wk period then treatments were reassigned to new pastures for a second three wk period in Fall 2000. In Exp.1, daily supplement consumption (DCON) for GNV averaged 2.58 kg (range 1.43 to 3.29 kg) and avg DCON for ONA was 1.93 kg (range 0.84 to 2.87 kg). Across both locations, DCON decreased 13% (P=.08) for T3.4, 30% (P<.01) for T2.9 and 64% (P<.01) for T2.3 compared to T4.2 (3.08 kg). In Exp. 2, DCON averaged 3.99 kg (range 2.55 to 5.38 kg) with decreases of 53, 38, 33, 30 and 18% (P<.02) from T4.2 (5.38 kg) for P2, S2, P3, C2, S3, respectively. DCON for C3 (4.89 kg) was similar (P=.13) to T4.2. Lowering pH of MOL was an effective method of reducing MOL consumption. Effectiveness of acid source varied, with P most and C least effective at similar pH.

Key Words: Beef Cattle, Molasses, Intake

1127 Effects of Plane of Nutrition on Milk and Weight Traits in Lactating Beef Cows. M. A. Johnson*, A. D. Herring, L. J. Hughes, and P. D. Bleick, *Texas Tech University, Lubbock, Texas*.

Twenty-eight lactating Angus cows were utilized to determine the effects of plane of nutrition on cow weight change, calf weight gain, milk yield, and milk composition (protein, fat, and somatic cell count (SCC)) from d 45 to 157 of lactation in 2000. Cows were randomly split into two groups (n = 14) and fed either a diet formulated to meet NRC maintenance requirements (MAINT) or one that exceeded maintenance requirements by 25% (MAINT125). Feed allotment was adjusted each 28 d period to reflect current cow weight and period of lactation. Diets consisted of a custom mixed protein/energy supplement and sorghum silage. Cows were machine milked every 28 d to measure milk yield, percent protein, percent fat, and SCC. Calves were separated from cows 16 h before milk collection, and cows and calves were weighed prior to milking. Data were analyzed as a repeated measures design with independent variables of diet, cow nested within diet, period, diet by period

interaction, calf sex, the regression on cow milk expected progeny difference (CEPD), and the regression on cow age in years; cow within diet was used to test diet effects. A time period effect (P < .01) was evident with all measured variables except SCC. Diet main effect was insignificant for all variables; however, a diet by period interaction was present (P < .05) for calf weight and milk protein. The interaction resulted because weight of MAINT125 calves was higher during the last three collection times when compared to MAINT calves, with a similar effect evident for milk protein. Calf sex (P < .01), CEPD (P = .047), and cow age (P = .048) additionally affected calf weight. CEPD ranged from -0.91 to 8.62 kg (3.63 kg average), and influenced milk yield (P < .01) and milk protein (P < .01). Average milk yields for collection times 1 through 5 were 5.4, 5.2, 4.8, 4.6, and 4.2 kg, respectively. Cow weight varied between collection times (P < .01) and was influenced by cow age (P < .01). Average initial (and final) weights for MAINT and MAINT125 cows were 577 (565) kg and 584 (581) kg, respectively. These data suggest that enhanced performance and milk composition does not result when Angus cows are fed 25% above maintenance requirements.

Key Words: Beef Cows, Milk Production, Weight

1128 Effects of feedbunk management strategies and monensin levels on feedlot performance in cattle fed to harvest. G.J. Vogel¹, J.C. Parrott¹, S.B. Laudert¹, and D.R. White¹, ¹Elanco Animal Health, Indianapolis, IN.

Two trials involving 3,408 crossbred steers with an average initial weight of 280 kg were conducted to evaluate the effects of different clean feedbunk times (i.e., targeted time for cattle to have consumed daily feed issue) and monensin levels on animal performance in cattle fed to harvest. Each trial consisted of 3 treatments with 6 replications. Treatments consisted of either a targeted clean feedbunk time of 0600 h with monensin included at 29 mg/kg of diet DM (T29), or a targeted clean feedbunk time 8 h earlier at 2200 h with monensin included at either 29 (C29) or 36 (C36) mg/kg of diet DM. Tylosin was fed throughout both trials to all cattle at 90 mg/d. Animals were fed twice daily at 0600 and 1300 h. Feedbunks were evaluated at 0600, 2000, 2200, and 0000 h for feed availability. Feed delivery was adjusted daily based on feedbunk readings. Cattle pen weights were obtained for each pen at the start of the trial, re-implant time, and at slaughter. All animals which died during the trial were necropsied. Data were analyzed as a randomized complete block design using pen as the experimental unit. Orthogonal contrasts were conducted to evaluate clean feedbunk time and monensin levels within clean feedbunk time. In trial 1, no differences in DM intake (7.81, 7.72, 7.73 kg), daily gain (1.31, 1.28, 1.32 kg/d) or final weight (505, 502, 509 kg) were noted among treatments T29, C29, and C36, respectively (P>.05). In trial 2, DM intake (8.83, 8.58, 8.51 kg), daily gain (1.52, 1.47, 1.46 kg/d) and final weight (557, 548, 548 kg) were reduced (P<.05) for cattle on the earlier clean feedbunk time at both monensin levels. Across both trials feed conversions were improved within the earlier clean feedbunk time with increased monensin level [5.92 (C29) vs 5.84 (C36); P<.05]. No differences in digestive death loss were observed among the treatments (.08%, .23%, .30%; P>.30). Results from these trials indicate that animal performance may be reduced if DM intake is compromised when an earlier clean feedbunk time is used. Feed conversions are also improved when higher levels of monensin are fed.

Key Words: Cattle, Monensin, Feedbunk Management

1129 Serum concentrations of trenbolone acetate and estradiol benzoate in cattle implanted with coated SYNOVEX Plus long-acting implants. L. A. Kraft¹, D. M. Henricks², S. Gray², A. N. Sinha¹, and K. L. Simkins¹, ¹Fort Dodge Animal Health, Princeton, NJ, ²Clemson University, Clemson, SC.

Commercial SYNOVEX Plus (SP) implants were coated (15% w/v) to extend the release of trenbolone acetate (TBA) and estradiol benzoate (EB) for about 200 days. Thirty Hereford crossbred steers (250-350 kg) were used to compare the serum concentrations of TBA and EB from coated Long-Acting (LA) and SP implants in cattle for 200 days. The cattle were blocked by pretreatment body weight and randomly assigned to one of the two implant groups within each block. All animals received either a LA implant or a SP implant in one ear. All implanted cattle were maintained together on pasture and supplemented daily with 1-2 kg/hd of a 16% crude protein concentrate. Ears were examined on Days 1, 4, 7, 14, 21, 28, 42, 56, 70, 91 and 112 for inflammation and presence of implants. Implants were detected in all animals through Day 70, but

could not be detected with certainty after Day 70 due to the normally expected depletion and decrease in size. Implant site reactions were minimal. Blood samples were obtained from the contralateral jugular vein on Days -2, -1, 0, 1, 4, 7, 14, 21, 28, 42, 56, 70, 91, 112, 133, 154, 175 and 200. Serum samples were assayed for trenbolone-17 β (TBOH) and estradiol-17 β (E₂), the active metabolites of TBA and EB. Serum TBOH for the LA implant was lower (P<0.10) than for the SP implant on Days 1-42 and higher (P<0.10) on Day 133. Similarly, serum E₂ was lower for the LA implant on Days 7-56 and higher on Day 133. The areas under the curve (AUC), the maximum analyte concentration (C_{max}) and time at which it was observed (T_{max}) were calculated. There were no differences (P>.10) in C_{max} for the LA and SP implants (317±37 vs. 347±33 pg/ml for TBOH and 12.5±1.8 vs. 11.3±0.9 pg/ml for E₂). However, the T_{max} for TBOH was 55±13 days for the LA implant compared to 19±4 days for the SP implant. The respective T_{max} values for E₂ were 122±14 and 44±8 days. The AUC for serum TBOH was lower (P≤.10) for the LA implant than for the SP implant suggesting that the coated LA implant was not completely depleted by Day 200 when serum TBOH was 13.7 pg/ml compared to 1.6 pg/ml for the SP implant. In summary, coating the commercial SYNOVEX Plus implant significantly reduced the early release of TBA and EB resulting in an extended release implant that lasted approximately 200 days.

Key Words: Beef Cattle, Trenbolone Acetate, Estradiol Benzoate

1130 Factors affecting net value of feedlot steers. N.K. Grathwohl¹, W.B. Epperson¹, B.J. Johnson², and S.W. Fausti¹, ¹South Dakota State University, ²Kansas State University.

Data from 874 steers enrolled in South Dakota State University's Calf Value Discovery (CVD) Program (1998 and 1999) were used to investigate factors affecting net value of feedlot steers. This analysis was conducted to evaluate how ranch of origin management (ROM) and feedlot health impact economic value. An OLS regression procedure was employed to analyze the data. The dependent variable, net value, was defined as: carcass revenue - feedlot cost. Overall fit of model was good as indicated by coefficient of determination R²=.9569. Regression results for health and ROM factors affecting net value is provided in the table below. Factors in the table are defined as: a) prewean was a categorical variable whose value was dependent on the days from weaning to feedlot entry - 0=if steers were weaned 0-3 d before entry, 1=if steers were weaned 4-14 d before feedlot entry, 2=if steers were weaned 15-29 d before feedlot entry, 3=if steers were weaned 30-44 d, and 4=if steers were weaned > 45 d before feedlot entry; b) modified live vaccine - if calf received a modified live viral IBR/BVD/BRSV/PI3 vaccine prior to feedlot arrival; c) in weight - weight (kg) of the calf at arrival to feedlot; and d) respiratory illness - if calf was treated for respiratory illness in feedlot. Results from this study found respiratory illness at the feedlot reduces net value of feedlot steers, while use of a modified live vaccine and preweaning at the ranch increases net value along with in weight. As anticipated, these factors contributed relatively little to overall net value. However, these data suggest ROM and health can impact the net value of feedlot steers at harvest. A more thorough understanding of these factors may help producers increase the net value of their product.

Factors	Parameter			
	Estimate	SE	Partial R ²	P-Value
Prewean	1.9698	.9560	.0003	.0398
Modified Live Vaccine	13.5639	2.2133	.0032	.0001
In Weight (kg)	1.2625	.0263	.1639	.0001
Respiratory Illness	-22.0417	3.6710	.0027	.0001

Key Words: Beef Cattle, Management, Health

1131 A systems approach for adding value to Montana feeder calves. D. J. Fennewald*, J. A. Paterson, R. N. Funston, and L. P. Anderson, *Montana State University-Bozeman Bozeman, MT.*

ABSTRACT: Two thousand eight hundred ninety-eight calves from 12 ranches were individually identified to evaluate if a standardized weaning protocol following prescribed vaccinations, nutrition and 45-d of backgrounding could reduce morbidity from weaning to harvest. Freshly

weaned calves were allocated to 1) CONTROL (defined as present weaning practices which may or may not provide pre-weaning vaccinations and do not retain calves for 45 d after weaning) or 2) TREATMENT (calves fed either 1.82 kg/d of a pellet or 0.45 kg/d of liquid supplement for 28 d containing additional levels of Cu, Zn, Mn, CP, vitamins A and E and a coccidiostat). Ranches chose viral and clostridial vaccines (MLV or killed) and described pre- and post-weaning management. Calves were fed in six states. Seven of the ranches divided calves into control and treatment groups (826 and 855, respectively) while three ranches had only treatment (n = 835) and two ranches had only control (n = 382). Results suggested calf morbidity was reduced (P<0.05) for calves backgrounded for 45-d or longer compared to calves backgrounded less than 45 d (6 vs. 21%). Death loss was lower (P<0.001) for 45-d backgrounded calves (0.3%) vs. 2.4% for calves backgrounded less than 45-d. Although not significant (P=0.17) calves fed the treatment pellet appeared to numerically have lower morbidities from weaning until harvest (6.3%) compared to control calves (19.5%). Range in morbidities was 0-100% for control vs. 0.5-20.9% for treatment. Boosting vaccinations appeared to help reduce (P=0.18) morbidity in the feedlot (7.4% for calves that received boosters vs. 21% for calves that received a single vaccination). Carcasses from six ranches were priced the week of harvest to compare gross income when priced as a base carcass price, on a quality or on a yield grade grid. Carcass weight correlations to gross income were 0.939, 0.838 and 0.926 when priced as a base carcass price, on a quality or on a yield grade grid, respectively (P<0.0001). Morbidity and death loss may be reduced when a weaning management strategy includes nutrition, proper vaccination and 45-d backgrounding. Carcass weight was highly correlated to gross income by marketing heavier carcasses that did not exceed industry specifications.

Key Words: Beef cattle, Weaning, Morbidity

1132 Predicting nutrient balance in the feedlot. H. Fairweather, K. A. Beauchemin, and K. M. Koenig, *Agriculture and Agri-Food Canada, Research Centre, Lethbridge, AB, Canada.*

There is a one-time feeding capacity of over 1,000,000 head of beef cattle in a 70,000 ha area in Southern Alberta. Therefore, there is a potential for nutrients to cease being an asset to the production system and become a liability to the environment. A whole system model (FeedNuts) is being developed to predict the nutrient balance in the feedlot by means of a daily time step stochastic simulation. The model was run for a 1000 head feedlot; cattle were fed a ration of 90% barley grain, 6% barley silage and 4% canola meal (DM basis). Initial weight of the cattle was 350 kg, final weight was 575 kg, and the feeding period was 150 d. Predicted N intake in the feedlot for the entire period was 38.1 t and the predicted P intake was 6.9 t. At the end of the simulation there was 1.7 t of soluble N and 9.1 t of insoluble N in the manure stockpile. A total of 14.9 t of N was volatilized from the manure (5.8 t during the time the animals were in the feedlot and 9.1 t in the 4 months the manure was stockpiled), 7.3 t was lost in runoff, all of which was volatilized from the holding pond. No P was lost to volatilization, however 0.2 t of P was lost in runoff and the manure stockpile contained 0.3 t soluble P and 5.5 t of insoluble P. This resulted in manure containing 3.0% total N and 1.6% total P (DM basis). Most crops take up from 5 to 13 times the amount of total N to total P and, therefore, if this manure was applied to a cropping system to meet the N requirement, P would accumulate in the soil. The system becomes more unbalanced if the losses of N in the soil are compared with the relatively small losses of P. Another complicating factor is the percentage of each of the nutrients in the applied manure that is available for crop uptake. The FeedNuts model simulates each of the pathways and changes in the nutrients as a function of different rations and provides a mechanism for investigating the nutrient balance at any point in time by conducting 'virtual' experiments. These experiments predict considerable variation in the soil nutrient balance for different rations.

Key Words: Nutrient balance, System model, Simulation

1133 Farm-level management practices of cattle: Effects on Enterohemorrhagic *Escherichia coli* and *Salmonella* in feedlot cattle. A.D. Herring¹, A.R. Barham*¹, S.K. Misra¹, C. Akers¹, and J.R. Blanton Jr.¹, *Texas Tech University, Lubbock TX.*

The objective of this study was to generate preliminary evidence to investigate the potential that farm-level management of cattle may affect

shedding of Enterohemorrhagic *Escherichia coli* (EHEC) and *Salmonella* (SAL) in the feedlot. Cattle from 5 climatic/geographical origins within Texas were studied. Management practices were: origins 1, 2, 3 and 4 utilized stocker-managed cattle, whereas origin 5 utilized backgrounded animals. Origins 1 and 3 employed an implant during the pre-feedlot period. Animals from origin 1 were 25% Brahman-25% British-50% Continental, origins 2 and 5 were 25% Brahman-75% British; origin 3 were 50% British-50% Continental and origin 4 cattle were 100% British. Steers composed all treatment groups except 9 heifers in origin 2. Fecal grab samples were collected prior to and following shipment to feedlot, on day 56 of the feedlot period, and prior to and at the slaughter facility. On arrival at the feedlot, cattle (n = 84) received clostridial and respiratory disease vaccinations, pour-on insecticide, and were assigned to pens (n = 6 anim) blocked by origin. Diets consisted of a corn-based grower/finisher ration that exceeded NRC requirements. Fecal grab samples were collected pre- and post-feedlot arrival, on day 56 of the feedlot period and pre- and post-exsanguination. EHEC and SAL prevalence were evaluated utilizing FSIS approved protocols. Pen was experimental unit with percent incidence analyzed using GLM procedures with a model that included origin, time, pen (origin) and origin*time interaction. EHEC levels were effect by origin (P < .05). Origin 4 had the highest incidence level of EHEC shedding (20.3%), whereas origin 3 had the lowest incidence (2.5%). While there were not any significant origin or time main effects for SAL, there was an origin*time interaction (P < .05). SAL incidence increased over time for origins 2 and 4, but decreased for origins 1, 3 and 5. Overall, these data indicate that cattle origin (location, management etc.) can result in different level of EHEC and SAL shedding in feedlot cattle.

Key Words: Salmonella, Escherichia coli, Cattle

1134 The Effect on Economics of Integrating Pasturing Systems into Cattle Finishing Programs. H Koknaroglu*¹ and M.P. Hoffman¹, ¹Iowa State University.

A three-year study, using 84 fall-born and 28 spring-born calves of similar genotypes each year, was conducted to integrate pasturing systems with drylot feeding systems. Fall and spring-born calves were started on test in May and October, respectively. Seven treatments were imposed: 1) fall-born calves directly into feedlot; 2 and 3) fall-born calves put on pasture with or without an ionophore and moved to the feedlot at the end of July; 4 and 5) fall-born calves put on pasture with or without an ionophore and moved to the feedlot at the end of October; 6 and 7) spring-born calves put on pasture with or without an ionophore and moved to the feedlot at the end of October. A 12.1 ha bromegrass pasture divided into 16 paddocks was available. Each treatment group had access to one paddock at a time and was rotated approximately at 3 day intervals. In the feedlot, steers were provided an 82 % concentrate diet containing whole-shelled corn, ground alfalfa hay, a protein, vitamin and mineral supplement containing ionophore and molasses. When pens of cattle reached approximately 522 kg average live weight, they were processed and carcass traits were evaluated. Overall, cattle started directly in the feedlot gained faster (P<0.001). Treatment influenced yield grade (P<0.001), however all treatments were YG 2. All treatment groups graded 75 % Choice or higher. Cattle started directly in the feedlot were the least profitable (\$-16 vs \$27; P<0.001). Cattle not receiving ionophore on pasture were a little more profitable (\$29 vs \$25; P>0.7), except fall-born cattle moved to the feedlot in October (\$22 vs \$30). Feeder and carcass prices were the two most important variables explaining the variation in profitability. These results indicate that cattle fed on pasture for varying periods of time produced acceptable carcasses and that feeder and carcass prices were the two most important variables affecting profitability. Thus, the timing of marketing is critical for optimizing profit.

Key Words: Steers, Feedlot, Pasture, Economics

1135 Repeated administration of implants to Holstein steers increases average daily gain, longissimus muscle area and the percentage of USDA Select carcasses. J.M. Scheffler*, D.D. Buskirk, S.R. Rust, J.D. Cowley, and M.E. Doumit, Michigan State University, East Lansing, MI.

The objective was to determine the effect of repeated use of implants on feedlot performance and carcass characteristics. Holstein steers (n=128) weighing an average of 211 kg were blocked by weight and randomly assigned to 16 pens. At the initiation of the trial (d 0), pens were assigned

to one of four treatments: non-implanted control (C), implant on d 0, d 100 and d 200 (I3), implant on d 100 and d 200 (I2) and implant on d 200 (I1). ComponentTM TE-S implants (120 mg trenbolone acetate and 24 mg estradiol per implant) were used for all treatments during the 268-day feeding period. During the first 200 d of trial, implanted steers had higher ADG compared to non-implanted steers (P<.01). Only I1 steers had greater ADG than C during the last 68 d (P<.05). Steers were harvested at a commercial abattoir on d 269. Hot carcass weights of I2 and I3 were similar to each other and greater than C and I1 (P<.05). Dressing percentage, adjusted 12th rib fat, percent kidney, pelvic and heart fat, yield grade and CIE L*a*b* values were not different between treatments. Longissimus muscle areas (LMA) from I2 and I3 were larger than LMA of C (P<.01). No USDA Select carcasses were produced from control cattle, while the percent Select from implanted cattle ranged from 9-17%. Repeated administration of ComponentTM TE-S implants improved ADG and resulted in heavier carcasses with larger LMA, but increased the percentage of carcasses grading USDA Select.

Key Words: Implants, Holstein, Average daily gain

1136 Effects of pre and/or postpartum fat supplementation on reproduction in mature beef cows. S.K. Johnson*, J.S. Stevenson, K.R. Harmony, and J.R. Brethour, Kansas State University.

The objective of this study was to determine the effects of level of supplemental fat either prepartum, postpartum or both on reproduction in beef cows fed a sorghum-sudan hay base diet. Multiparous crossbred cows (n=269) received a low fat milo-based supplement (2% EE, 18% CP; 2.7 kg/hd/d; LF) or a high fat sunflower-based supplement (26% EE, 18% CP; 1.6 kg/hd/d; HF) either prepartum (PRE) or postpartum (POST) in a 2 x 2 factorial arrangement of treatments. Sorghum-sudan hay was offered ad libitum and ranged in quality from 5 -12% CP. The lowest quality hay was fed prepartum. Mean length of supplementation was 64 d PRE and 76 d POST and continued through a 5-d AI period. Two blood serum samples were collected 14 d apart just before administering 25 mg of PGF_{2α} to synchronize estrus. At the end of the AI period, cows were transported to summer pastures and exposed to bulls for 53 d beginning 9 d after transport. No effect of type of supplement fed PRE was observed for reproductive measures. In contrast, the proportion of cows cycling at the beginning of the breeding season (74% vs 65%) and the pregnancy rate to AI (44% vs 32%) was greater (P<.05) for cows receiving LF as compared to HF POST, respectively. Level of fat supplementation had no effect on pregnancy rate for the entire breeding season (95.4%). Cows fed LF POST had a higher body condition score (BCS) at breeding (5.2 vs 4.7), lost less BCS from calving to breeding (-0.3 vs -0.6) and weighed more at breeding (497 vs 482 kg) than HF cows, respectively (P<.05). There was no difference in cow weight or BCS at weaning due to treatment; however, cows receiving HF POST gained condition from breeding to weaning while LF cows lost condition during the same time period. Calf birth weight, calving difficulty score, and calf weaning weight did not differ due to treatment. Increased supplemental fat fed prepartum, postpartum, or both did not improve reproductive traits of mature cows in a herd already in good body condition and with high reproductive performance.

Key Words: Cows, Fat supplementation, Pregnancy rate

1137 Comparison of pregnancy rates in beef cows for two synchronization regimens using GnRH, PGF_{2α} and MGA. W.A. Greene and M.L. Berger*, The Ohio State University, Wooster USA.

Seventy-seven beef cows were allotted to two similar groups based upon breed, age, postpartum interval, and postpartum cyclicity (as determined by ultrasonography) to compare pregnancy rates (PR) resulting from two synchronization regimens using GnRH, prostaglandin F_{2α} (PGF_{2α}), and melengesterol acetate (MGA). Both groups received 50 μg GnRH i.m. on d 0 and 25 mg prostaglandin F_{2α} (PGF_{2α}) i.m. on d 7. Group 1 was fed MGA from d -26 to d -12 at a rate of .5 mg/cow/d. These cows were observed for estrus 0700 and 1900 and were artificially inseminated (AI) 8-16 h after estrus was observed or 80 h after PGF_{2α} if estrus was not observed. Group 2 was fed MGA (.5 mg/cow/d) from d 0 to d 6, received a second GnRH i.m. on d 9 (48 h after PGF_{2α}), and were AI 16 h after the d 9 GnRH injection. Following the synchronization period, repeat breedings were done until d 58. Cows were

pregnancy diagnosed by ultrasonography on d 84. PR to synchronization (PR-SYNC) and overall PR were similar for both groups ($P > .05$). PR-SYNC for Groups 1 and 2 were 59.5 and 55.0%. Overall PR for Groups 1 and 2 were 94.6 and 87.5%. PR-SYNC tended to be higher for cycling cows (61.7 vs. 41.2%, $P = .17$) while overall PR was not affected ($P > .05$) by postpartum cyclicity status at time of synchronization.

1138 Predicting resistance to compression of wool fibers. F.A. Pfeiffer*, C.J. Lupton, and B.A. Kuykendall, *Texas Agricultural Experiment Station, San Angelo, Texas/USA.*

Resistance to compression (RTC) is the force per unit area required to compress a fixed mass of wool to a fixed volume. Units of measure are kilopascals (kPa). Together with other important characteristics such as staple length (SL) and average fiber diameter (AFD), RTC is used to predict processing and product performance of wool, this being part of the value determining process for some raw wools. Objective measurement of RTC requires several preparation steps (washing, drying, carding, and conditioning) and a specialized testing apparatus not generally available in U.S. wool testing labs. On the other hand, fiber diameter distribution is now routinely measured by fast, accurate, high-tech instruments. Recently, the capabilities of one such instrument, the Optical Fiber Diameter Analyser, were expanded to include concurrent measurement of fiber diameter and fiber curvature (FC) distributions. One hundred and four samples representing a broad cross section of commercially available wools were quantified individually using standard methods for SL (mean = 9.6 cm, range 6.1 to 18.2 cm), AFD (24.1, 18.0 to 43.1 μm), FC (82.9, 20.0 to 121.1 degrees per cm), clean yield (CY; 67.1, 41.4 to 88.7 %), vegetable matter content (VM; 1.6, 0.1 to 6.7 %), crimps per unit length of staple (CR; 3.9, 0.7 to 7.0 crimps per cm), and RTC (9.1, 6.7 to 13.1 kPa) in order to study the relationships between RTC and the other measured traits. Resistance to compression was shown to be significantly ($P < 0.05$) but not highly correlated with SL, AFD, FC, CY, and CR ($r = -0.36, -0.21, 0.57, -0.52, \text{ and } 0.42$, respectively). As expected, FC was highly correlated with CR and AFD ($r = 0.94$ and -0.83 , respectively). Stepwise multiple regression analysis was used to predict RTC using all the measured variables (and their SD values for all traits except CY and VM). The resulting equation was $\text{RTC} = -2.13 + 0.22 \cdot \text{AFD} + 0.07 \cdot \text{FC}$, $r^2 = 0.54$. No other variables met the 0.01 significance level for entry into the model. We concluded that for textile applications in which a specific RTC is required, it still will be necessary to measure this characteristic directly because it cannot be accurately predicted using other raw fiber traits.

Key Words: Wool, Resistance to compression, Fiber traits

1139 Evaluation of forages for outdoor gestating sows. H. A. Rachunyo*¹, V. G. Allen¹, J. L. Morrow-Tesch², J. W. Dailey², and J. J. McGlone¹, ¹*Texas Tech University, Lubbock*, ²*USDA-ARS, Lubbock*.

Sustainable outdoor pig production requires vegetation that can maintain ground cover, take up manure nutrients, and prevent soil erosion. Two studies were conducted using 4 forages, alfalfa (*Medicago sativa*), tall fescue (*Festuca arundinacea*), white clover (*Trifolium repens*) and buffalograss (*Buchloe dactyloides*). Individual plots of single forage covered about 6 m². In first study, 8 pregnant gilts were given free access to 4 blocks of forages during a 2-d adjustment period and then gilts (2 per block) were assigned randomly to four blocks of 4 forages. Percentage ground cover was visually estimated at time 0, 24, and 48 h of study and analyzed as a split plot. Behavior data including walking, eating, grazing, rooting, drinking, standing, lying, and time-spent in-hut were monitored continuously by camera for 48 h. Percentage ground cover, which started at 100%, was reduced ($P < .01$), especially for clover (48.70.63%) and alfalfa (62.50.63%) but not for fescue (98.70.63%) or buffalograss (98.70.63%). In a second study, six gilts from the initial group were used; each one was assigned randomly to individual forages. Clover was excluded in second study because of damage by gilts during first phase. Rate of loss for percentage ground cover was higher ($P < .01$) for alfalfa than buffalograss or fescue (-31.3, -1.7, -1.8%/d, respectively) in second study. Behavioral analysis in first study showed that sows spent more ($P < .01$) time grazing clover (16.3 1.97 min) and alfalfa (11.2 1.97 min) than fescue (.81.97 min) or buffalograss (.31.97 min), and rooted more ($P < .04$) clover than other forages. In second study, gilts spent more ($P < .01$) time grazing alfalfa (15.82.36 min) than buffalograss (1.52.36 min) or fescue (0.72.37 min). Pigs have clear preferences for grazing alfalfa and clover, and rooting clover. Rates of loss of ground cover were

lower for fescue and buffalograss than other more preferred forages and, thus, these forages may have potential in pastures for swine to provide ground cover. Longer-term studies are needed.

Key Words: Pig, Environment, Forage

1140 Improving the viability of piglets with oxygen. J Zhang, V Osborne, M Fan, and R Hacker*, *Dept. of Animal & Poultry Science, University of Guelph, Guelph, Ontario Canada N1G 2W1.*

The objective of this study was to improve piglet viability and to reduce piglet mortality during the first 7 d of life with oxygen treatment. Two chambers (51x28x30.5cm) were purchased from a retail fish aquarium shop. The treatment chamber was fitted with a lid, an oxygen port and a monitoring port. Oxygen was supplied to the treatment chamber via a controller (#1630 Engineered Systems & Designs) which was connected to a mobile oxygen tank. Piglets (231) received oxygen immediately after birth or were maintained (232) in an identical control chamber with no supplemental oxygen. Temperature in both chambers was kept between 31 and 35°C and no more than three piglets occupied a chamber simultaneously. Oxygen content in the chamber was verified with a Stat Profile Plus-9 Component of NOVA Biomedical Canada Ltd. The movement of the piglets' front legs was counted in the first 20 s after removal from the chamber. Piglet BW was recorded at the birth and at d 7, with the difference used to calculate gain. Total mortality during the first 7 d of life was compared with 974 background piglets that were farrowed during the experimental period in the herd, with little or no attention during farrowing. Data were analyzed by the GLM procedure of SAS. Oxygen inhalation for 10 min improved ($P < 0.05$) piglets' movement and weight gain compared with the 10-min control group. However, there was no difference ($P > 0.05$) between the 15-min groups. Cumulative mortality of all experimental groups during the first 7 d after birth was lower ($P < 0.01$) than that for the background group. This was especially true for the 10-min oxygen group, which was lower ($P < 0.01$) than the background group by 88.0% during the first 3 d of life (0.8 vs. 6.9% on d 1 and 0.8 vs. 8.0% at d 3). It can be concluded that providing 10-min of oxygen immediately after birth increases piglet viability and growth during the early postnatal period.

Key Words: Oxygen, Temperature, Mortality

1141 The impact of farrowing crate design on litter performance traits in swine. S.J. Moeller*, K.M. Irvin, K.R. Black, and S.M. Neal, *The Ohio State University, Columbus, OH.*

Litter records representing 1,249 multi-parous females were used to evaluate the impact of farrowing crate design on litter, piglet and sow performance traits. Five farrowing crate designs with variability in lower bar design, width of crate and orientation within farrowing pen were compared. The crate designs were: B1, 188 x 42 cm, finger side; B2 188 x 47 cm, finger side; K1, 185 x 42 cm, finger side; K2 185 x 42 cm, bow-bar side; and Z, 197 x 42 cm, finger side. Total farrowing pen space was 213 x 152 cm for B1, B2, K1 and K2, and 213 x 137 cm in the Z-crate. The Z-crate was placed diagonally within the pen and pen size was smaller by design. Farrowing crates were randomly placed with sows randomly assigned to crates upon entering the farrowing facility. Subsets of crate-type were evaluated in statistical models to evaluate crate width (narrow vs wide), lower-bar type (finger vs bow-bar), or manufacturer type. Statistical analyses were performed using mixed model procedures of SAS, with a random effect of farrowing group and fixed effects of parity, female breed and crate characteristic. Interactions were tested. Covariates were used to standardize litter traits to a 21 d lactation length where appropriate. Twenty-four dependent variables were evaluated encompassing birth and weaning numbers, survival rates, litter weights, female weight loss and fat loss. Results comparing B1 vs B2 (narrow vs wide) finger crates (N=627) revealed no differences in pig, sow, or litter measures. Litters raised in bow-bar crates (K2, N=269) were found to have significantly ($P < .05$) more pigs (.34 pigs/litter) and heavier litter weight (2.18 kg/litter) at 21 d than finger-crates (K1, N=186). The number of pigs dying within 1 d of birth was significantly higher ($P < .05$) in the Z-crate (0.80 pigs) when compared to the K1 crate (0.54 pigs), but no differences were found in number of pigs weaned at 21 d. Parity and female breed effects were significant for most traits measured. In this study crate width did not impact sow or

litter performance. However, bow-bar crate type resulted in more pigs and heavier litter weights at 21d.

Key Words: Swine, Farrowing, Litter

1142 Supplemental feeding lactating Fallow does increased body condition score and circulating leptin but failed to improve reproductive efficiency. K. C. Candler^{*1}, C. G. Brown¹, D. A. Neuendorff¹, A. W. Lewis¹, J. A. Sterle², D.H. Keisler³, and R. D. Randel¹, ¹Texas Agricultural Experiment Station, Overton, ²College Station, ³University of Missouri, Columbia.

Gestating does (*Dama dama*); (BW=51.3kg) were allotted into groups: 1) Control (C; No Supplement n=12), 2) Supplement (S; 4:1, corn:soybean meal n=12), or 3) Rice Bran (R; 3:1:1, corn:soybean meal:20% fat rice bran n=12) formulated to be isonitrogenous and isoenergetic and grazed Coastal bermudagrass/ryegrass pastures. S and R were fed .5kg ration/head/day for 112d. All does were weighed, body condition scored (BCS), and blood sampled at 7d intervals for 14d prior to and for 35d after weaning. Serum progesterone (P4) and leptin concentrations were determined using RIA. Pregnancy was determined by ultrasonography 30 and 75 d after buck exposure. S does tended (P<.075) to lose less weight (-.062±.004kg/d) than C (-.073±.004kg/d) or R (-.071±.004kg/d). C does tended (P<.08) to have lower BCS than R but were lower (P<.002) than S. S does lost less (P±.001) BCS (-.636±.310) than C (-2.167±.297) with R being intermediate (-1.432±.310). Fawn birth weights did not differ (5.2±.2kg/d, 5.1±.2kg/d, 5.3±.2kg/d; C, S, and R, respectively). C fawns had the lowest (P<.003) ADG (.128±.010kg), S the highest (.185±.010kg) and R intermediate (.162±.010kg). Serum leptin (ng/ml) increased over time (P<.001) and differed by treatment (P<.06) with S being the highest and C and R being similar (P<.10) and lowest. Preweaning P4 was higher (P<.003) in S (2.4±.2ng/ml) than either C (1.5±.2ng/ml) or R does (1.7±.2ng/ml). 100% of S does were estrous cycling before weaning compared with 66% of C and 75% of R. Postweaning P4 increased over time (P<.0001) but was not affected by treatment (P>.10). By d 30 of the breeding season, 100% of S does were pregnant compared with 91% of C and R and all does were pregnant by d 75. Inclusion of rice bran failed to improve performance but supplement corn and soybean meal supplement increased

BCS and circulating leptin. Weaning and buck exposure resulted in equal breeding performance in thinner does.

Key Words: Rice bran, *Dama dama*, Dietary energy

1143 Angus steer performance grazing bermudagrass on degraded soils fertilized with poultry litter, ammonium nitrate, or crimson clover. D. H. Seman^{*1}, J. A. Stuedemann¹, and A. J. Franzluebbers¹, ¹USDA-ARS, Watkinsville, GA USA 30677.

We have been investigating the impact of using cattle in forage systems to restore degraded cropland in the Southeastern US. The object of this study was to evaluate performance of steers grazing bermudagrass pastures that were fertilized by three fertilizer treatments and were stocked at two grazing pressures. Yearling Angus steers were randomly assigned to 18 paddocks (.65 to .75 ha) which were organized in three blocks. Three nitrogen (N) treatments included N provided as ammonium nitrate (M), poultry litter (L) or by crimson clover plus ammonium nitrate (C). Ammonium nitrate and L were applied twice each year to annually provide 200 kg N/ha. Cattle grazed for 140 days from mid-May until mid-October for five years. The high grazing pressure (HP) was to maintain 1,500 kg forage/ha and low grazing pressure (LOW) maintained 3,000 kg/ha with a differential of 1,500 kg/ha between both rates. Stocking rates were adjusted every 28 days by put-and-take. After five years, the M treatment had greater average total grazing days (1,092) than C (926) and L (944), (P<.05). The L treatment had less total animal gain/ha, 607 kg/ha than did M (733 kg/ha) and C (688 kg/ha) treatments (P<.05). Average daily gain (ADG) was greater for C (.78 kg/d) than L (.69 kg/d) (P<.05) with M intermediate (.74 kg/d). Steers grazing HP had 1,118 grazing days vs. 857 LOW (P<.05). Steers grazing HP had greater total animal gain/ha, 732 than LOW with 620 kg/ha (P<.05). Steers grazing LOW had greater ADG .82 kg/d than HP .65 kg/d (P<.05). Steers exhibited excellent gains while grazing bermudagrass during summer. Poultry litter supported acceptable steer production even though animal production was less than M and C. Soil organic carbon was positively correlated with grazing days $r=.49$ (P=.0378). Results imply that grazing cattle can be employed to restore eroded cropland.

Key Words: Poultry Litter, Beef Cattle

ASAS/ADSA Animal Behavior and Well Being

1144 Quiet handling of heifers reduces aversion to restraint. V. Littlefield¹, T. Grandin¹, and J. L. Lanier^{*1}, ¹Colorado State University.

On eight non-consecutive days, 192 Hereford x Charolais heifers were restrained in a scissors type, hydraulic squeeze chute. Squeeze chute temperament and balking behavior was scored with 4-point scales. Squeeze chute temperament scores were 1= calm, stood still, 2 = struggled once, 3 = struggled multiple times, flexed shoulder muscles, and 4 = violent and consistent struggling. Balking behavior at the squeeze chute entrance was 1= entered chute without hesitation, 2 = Hesitation, moved into chute after being touched, 3 = Hesitated, tail twisted, and 4 = electric prod used. Gentle and quiet handling was maintained during all handling of the cattle, for all days. Squeeze chute and balking scores decreased with repetitive handling (P < .01). Mean squeeze chute score was reduced from 1.94 to 1.39 during the eight days. Balking before entering the squeeze chute was reduced from a mean of 1.89 on day one to a mean of 1.58 on day eight. Heifers with higher temperament scores typically entered the squeeze chute last (R2=.84, P<.01). Gentle, repetitive handling of cattle decreases balking in the handling facility and decreases reactivity to restraint in a squeeze chute. Cattle became easier to move into the squeeze chute with each successive handling.

Key Words: Cattle, Behavior, Temperament

1145 Genetic determination of maintenance behavior of calves. Jan J.J. Broucek^{*1}, Ted H. Friend², Clive W. Arave³, Paul Flak¹, Stefan Mihina¹, Michael Uhrincat¹, Anton Hanus¹, and Peter Kisac¹, ¹Research Institute of Animal Production, Nitra, Slovakia, ²Texas A&M University, College Station, USA, ³Utah State University, Logan, USA.

We assessed 21 Holstein calves (12 males and 9 females) descended from 3 bulls (AMS1, n=6; STB9, n=8; PEL2, n=7). The calves were kept in loose housing. We conducted three observations of maintenance behaviour, at 14 (A1), 16 (A2) and 19 (A3) weeks of age. The general activity of each of the animals was recorded at 10 min intervals over 24 hours. A significant effect of sire was found in the number of standing bouts (AMS1=36; STB9=38; PEL2=40, P<.05); a significant effect of gender in the time of lying (832 min males vs 802 min females, P<.05) and standing (608 min males vs 638 min females, P<.05), in the number of bouts when lying on the right side (20.1 males vs 18 females, P<.05) and standing (37.6 males vs 39.3 females, P<.05). The effect of age was highly significant in the time spent lying (A1=750 min; A2=826 min; A3=881 min, P<.01), in the time spent lying while ruminating (A1=325 min; A2=416 min; A3=450 min, P<.01), in the time of lying on the right side with rumination (A1=136.7 min; A2=157.6 min; A3=172.4 min, P<.01), in the time of standing (A1=690 min; A2=613 min; A3=559 min, P<.01), ruminating (A1=336 min; A2=442 min; A3=475 min, P<.01) and feeding (A1=289 min; A2=397 min; A3=327 min, P<.01), in the number of bouts lying while ruminating (A1=12.4; A2=15.8; A3=16.3, P<.01), number of bouts lying on the left side with rumination (A1=6.6; A2=8.8; A3=9, P<.01) and in the number of ruminating periods (A1=13.9; A2=18; A3=18.7, P<.01). A significant effect of age was found in the number of lying bouts on the right side (A1=17; A2=20.6; A3=20, P<.05). Significant interactions for sire x gender were found in the number of standing bouts (P<.05),

sire x age in the time of standing ($P < .05$), time of lying while ruminating ($P < .05$) and in the number of lying bouts on the right side ($P < .01$), and gender x age in the number of standing periods ($P < .01$). The results show that females stood more. Times spent lying, ruminating and feeding were increasing with the age, similar as the number of bouts lying while ruminating, lying on the left side with rumination, ruminating and lying bouts on the right side. We concluded from the analysis, that the effect of the sires' genotype was manifested only in the number of standing bouts.

Key Words: Calves, Behaviour, Sire

1146 Feeding behavior of lactating dairy cows as measured by real-time control system. Zadok Shabi^{*1}, Michael Murphy¹, and Uzi Moallem², ¹University of Illinois, ²A.R.O, The Volcani Center, Israel.

To increase milk production various management schemes are used by dairy producers. These include increase feeding-frequencies, cooling system, more milking per day, artificial lighting, processing of feedstuffs, and manipulating the diet composition. Using one of these management tools or combination of two or more might affect eating behavior. The effect of most of these management tools on daily eating behavior pattern is not yet known. Dairy producers can use knowledge of animal behaviour to improve cow well being and performance. A real-time control system for individual food intake of group-housed lactating dairy cows was used to evaluate feeding behavior. The system consists of 40 feeding stations, one for each cow. Each station equipped with individual identification system, on line scale and logic controller. These systems enabled measurement and recording for each visit the date, entrance time, exit time, and food consumed. Later, daily food consumption, number of visits, meal duration, and rate of food intake were calculated from the recorded database. The average daily intake was 36.0 kg as fed /d, time spent eating was 170.3 min/cow/d, and 12.0 visits daily. A statistic model, which combines two normal curves, was fitted to data from 2 mo during the summer. The bi-normal model explained more than 91.0% of variation in feeding behavior ($P < 0.01$). The first peak was at 0814 (mean sunrise 0508) with a CV of 24.0%. The second peak was at 1634 (mean sunset 1818) with a CV of 6.4%. The later the second peak in feed consumption, the more visits cows made to the feeder ($r = .363$, $P < 0.02$). The broader the second peak in feed consumption, the more total feed was consumed ($r = .378$, $P < 0.03$). On average, 61% of the total intake was associated with the first peak. These results have likely implications for scheduling milking and feeding times to maximize intake and production.

Key Words: Feeding behavior, Dairy cows

1147 Behavioral and physiological responses of calves to dehorning using a long acting local anesthetic. J. W. Forehand^{*1}, H. G. Kattesh¹, T. J. Doherty¹, M. G. Welborn¹, A. M. Saxton¹, J. L. Morrow², and J. W. Dailey², ¹University of Tennessee, Knoxville TN, ²ARS-USDA, Lubbock, TX.

Behavioral and physiological responses after dehorning by heat cauterization were measured in 32, 10 to 12-wk old female Holstein calves. Each calf was randomly allotted to one of four treatments; 5% lidocaine followed by dehorning (F), 2% lidocaine followed by dehorning (T), saline followed by dehorning (S), or 5% lidocaine followed by sham dehorning (C). Physiological responses were assessed by collecting blood via a jugular catheter at -0.5, 0, 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, 6, 9, 12, 24, 48, and 72 h. Feeding, drinking, scratching, grooming, rubbing, licking, and inactivity behaviors were observed in the standing and recumbent positions using a 10-min scan sampling method and analyzed on a time period and daily basis for 72 h following the procedure. Acute phase proteins and immunological components were determined at 0, 12, 24, 48, and 72 h. Plasma cortisol was not affected by treatment ($P = .07$) or treatment by time interaction ($P = .06$), but there was an overall significant ($P < .001$) time effect. Calves showed an immediate increase in cortisol within the first 0.5h (9.3 ± 1.1 vs. 18.8 ± 2.2 ng/mL) and again from the 4 h to 6 h samples (5.7 ± 1.4 vs. 10.4 ± 1.3 ng/mL). Fibrinogen concentration and neutrophil:lymphocyte (N:L) ratio were not altered ($P > .1$) by treatment. However, N:L was highest ($P < .01$) at 12 h. For the first 24 h post-dehorning, behaviors of all calves were similar and frequencies of scratching, licking, grooming, and head rubbing in the recumbent and standing positions were near zero. Treatment differences in recumbent inactivity were not significant ($P = .09$),

but there was an overall increase in inactivity for all groups over time ($P < .001$). Eating and drinking frequency were not affected ($P > .05$) by treatment. Thus, behavioral and physiological responses following dehorning by heat cauterization do not appear to be different in calves with or without prior administration of 2 or 5% lidocaine.

Key Words: Dehorning, Behavior, Anesthesia

1148 The effects of management stressors on cortisol production in various breeds of bulls. J.W. Koch^{*1,2}, S.R. Tatman¹, D.A. Nueundorff¹, T.W. Wilson¹, A.W. Lewis¹, C.C. Chase³, T.H. Welsh², and R.D. Randel¹, ¹Texas Agricultural Experiment Station, Overton, TX, ²College Station, TX, ³ARS, USDA, Brooksville, FL.

Beef management practices may induce stress responses in cattle. The influence of breed on response to transportation and restraint was studied using Angus ($n=7$, A), Bonsmara ($n=8$, BO), Brahman ($n=8$, BR), Romosinuano ($n=10$, R), Tuli ($n=10$, T) and Wagyu ($n=10$, W) bulls. Blood samples were obtained by tail venipuncture [5 min prior to and post transportation (30min, 18mile)] and by jugular cannula every 15 min for 6 h. Pre-transportation plasma cortisol did not differ among breeds (13.9 ± 3.5 , A; 4.5 ± 3.5 , BO; 12.6 ± 3.2 , BR; 9.5 ± 3.0 , R; 8.0 ± 3.0 , T; 5.2 ± 3.2 , W ng/ml, respectively). BR, R, A, and T had similar post-trailer cortisol concentrations (26.3 ± 4.0 , 24.3 ± 3.8 , 18.5 ± 4.4 , 17.1 ± 3.8 , respectively). However these values exceeded ($P < .02$) that of the BO (2.4 ± 4.4) bulls which was similar ($P > .22$) to the W (9.7 ± 4.0) bulls. Post-trailer cortisol did not differ among A, T and W bulls. R, BR and T had similar change of post-trailer and pre-trailer cortisol concentrations (14.8 ± 3.4 , 13.6 ± 3.6 , 9.1 ± 3.4 ng/ml), but greater ($P < .04$) than that of the BO (-2.1 ± 3.9). The R (14.8 ± 3.4) differed ($P < .05$) from the A and W (4.6 ± 3.9 , 4.5 ± 3.6) which were similar ($P > .08$) to that of the BO, T and BR (-2.1 ± 3.9 , 9.1 ± 3.4 , 13.6 ± 3.6). There was a breed difference ($P < .05$) for cortisol concentrations for the first two hours, but no difference for the second two or third two hours. The average plasma cortisol concentrations for all samples during the 6-h period, average cortisol for the middle two and last two hours and lowest cortisol concentration for the six h window did not differ ($P > .13$). BR, A, R and T had similar highest mean cortisol concentrations (25.7 ± 3.8 ; 25.5 ± 4.4 ; 22.5 ± 3.4 ; 21.1 ± 3.4 , respectively). BO and W had similar highest mean cortisol concentrations (12.9 ± 3.8 ; 12.6 ± 3.4), but this was lower than that of BR, A and R bulls. Various breeds of bulls respond differently to normal management stressors.

Key Words: Bulls, Transportation, Restraint

1149 Effects of cooling strategies on physiological responses to heat challenge. K. M. Spurlin^{*}, D. E. Spiers, M. Eilersieck, and J. N. Spain, University of Missouri - Columbia.

An environmental chamber study was designed to evaluate physiological responses initiated at various levels of heat stress with particular interest in digestive function. Thermal status measurements are summarized. Four fistulated cows were used to compare 4 cooling strategies. Treatments were 24 h (24h; continuous fan cooling), 12 h nighttime (12N; fans on between 1900 and 0700), 12 h daytime (12D; fans on between 0700 and 1900), and no cooling (NO). Treatments were administered during consecutive 14-d periods arranged as a 4x4 Latin Square. Cows were housed in a climate-controlled room during the experiment. Periods included 6 d thermoneutral (20 C), 3 d step-up, followed by 5 d heat challenge. During heat challenge, maximum ambient temperature reached 32 C between 1400 to 1800 and was lowered to 22 C from 0200 to 0600. On d 6 to 14, respiration rates (RR), skin temperatures at the tailhead (TT), rump (RuT), and shoulder (ST), as well as rectal temperatures (ReT) were recorded at 0500, 1000, 1500, 1900, and 2200 h. There were no treatment effects ($P=0.28$) for ReT; however, there was a trend toward significance for RR and TT ($P=.16$ and $P=.11$, respectively). These responses indicate animals were able to effectively respond to the thermal challenge. Mean RuT temps were 33.4, 33.7, 33.8, and 33.8C for 24h, 12N, 12D, and NO, respectively. RuT for the 24h group was lower than that of all other groups ($P < .05$); RuT for the 12N group tended ($P=.06$) to be lower than that for the NO group. Least square means for SS temperatures were 33.0, 33.2, 33.6, and 33.7 C for 24h, 12N, 12D, and NO, respectively. Both 24h and 12N ST were different ($P < .05$) from each other and the other 2 groups. A treatment by time interaction ($P < .05$) was only observed for ST measurements. All measurements had significant ($P < .05$) day, time, and day by time

effects. Animal responses indicate that the minimum nighttime temperature was low enough to allow sufficient heat loss to cool at night without fans. Regardless of cooling strategy, animals maintained thermal balance through effective thermoregulatory responses during the 5 d heat challenge.

Key Words: Heat stress, Thermal status, Cooling

1150 Evaluation of a model to predict internal body temperature in feedlot cattle during summer heat. L. E. McVicker*, M. J. Leonard, and D. E. Spiers, *University of Missouri, Columbia, MO.*

Exposure of feedlot cattle to summer heat in the absence of shade results in reduced overall performance. A 12-day field study was conducted in year 2000 to refine a predictive model of core temperature by comparison with our 1999 model. Angus x Simmental steers (445+/-9 kg; n=24) were kept in unshaded feedlot pens, and provided with a typical finishing diet and water *ad libitum*. Implanted telemetric temperature transmitters (CowTemp, Model BV-010) were placed in the peritoneal cavity (T_{core}) and rumen (T_{rm}) in years 1999 and 2000, respectively, to continuously monitor core temperature. Data loggers (Onset "Hobo") recorded ambient conditions, including percent relative humidity, air temperature (T_a), and black globe temperature (BG) to identify radiant heat load. Both temperature-humidity (THI) and black globe temperature-humidity (BGTHI) indices were calculated using these values. Initial comparisons showed that T_{rm} was 0.6°C higher than T_{core} at non-heat stress T_a of 25°C or less, with a gradual reduction to 0.3°C at 35°C. Temperature of both sites reached lowest level at 0700 and highest within 1-2 h of daily maximum T_a . Further analyses used only day values. Highest correlation coefficients for prediction of T_{core} (1999) were obtained with $T_a \times BG$ ($r = .90$; $P < .001$) and $THI \times BGTHI$ ($r = .89$; $P < .001$) values that preceded T_{core} by 1 h. In 2000, highest correlation coefficients for prediction of T_{rm} utilized $THI \times BGTHI$ ($r = .84$; $P < .001$) and $T_a \times BG$ ($r = .81$; $P < .001$) values at 3 h before T_{rm} . A second-order polynomial expression best described these relationships with only a 1-2 h delay. However, comparable correlations at a 3 h delay required only a linear expression. Changes in thermal status of cattle in a feedlot environment can be predicted using the combination of air and black globe temperature inputs. Predictive success is improved with inclusion of time delays of 1-3 h. Separate predictive equations for internal temperature must be developed for different core regions.

Key Words: Heat Stress, Models, Cattle

1151 Effects of simulated preslaughter holding and isolation on stress responses and live weight shrinkage in goats. G. Kannan*, T. H. Terrill, B. Kouakou, S. Miller, S. Gelaye, and E. A. Amoah, *Agricultural Research Station, Fort Valley State University, Fort Valley, GA.*

The objective of this experiment was to determine the effects of preslaughter feed withdrawal duration and isolation on physiological responses and shrinkage in goats. A total of 84 Spanish does (6 mo of age, average weight 35 kg) were individually weighed and scored for excitability before the two replicate (day) trials. The does were feed deprived (FD) or fed (F) in holding pens (treatment, TRT) for either 0, 7, 14, or 21 h (TIME). At the end of the holding periods, FD and F does were blood sampled (n = 6 does/treatment/time/replicate) and weighed again to assess physiological responses and shrinkage. Individual does from each pen were then subjected to one of three handling post-treatments (PTRT): a 15-min isolation with no visual contact with other does (I); a 15-min isolation with visual contact (IV); or no isolation (C, control). Blood samples were collected again after imposing PTRT. The data were analyzed as Split-Unit designs using MIXED procedures in SAS. Plasma cortisol concentrations were influenced by TIME ($P < 0.01$), but not by TRT when measured after the holding periods. Plasma T3, T4, and leptin concentrations, and differential leukocyte counts (neutrophil, lymphocyte, eosinophil, monocyte) were not influenced by any of the factors. Excitability scores did not have any significant effect on the variables measured. Shrinkage increased with increasing holding time ($P < 0.01$), but more prominently in the FD group (TRT x TIME, $P < 0.01$). The FD group also had greater shrinkage than the F group ($P < 0.01$). Plasma cortisol concentrations were greater in I and IV groups than in the C group ($P < 0.01$). The results

indicate that the novelty of environment during preslaughter holding may be a more potent stressor than feed deprivation in goats, although shrinkage may increase with increasing feed withdrawal times. Stress can significantly increase when animals go through the isolation chutes just prior to slaughter.

Key Words: Goats, Preslaughter holding, Isolation stress

1152 Effect of animal handling method on the incidence of stress response in market swine in a model system. M. E. Benjamin*¹, H. W. Gonyou², D. J. Ivers³, L. F. Richardson³, D. J. Jones³, J. R. Wagner³, R. Seneriz³, and D. B. Anderson³, ¹Elanco/Provel Animal Health, Calgary, Canada, ²Prairie Swine Centre, Saskatoon, SK, Canada, ³Elanco Animal Health, Greenfield, Indiana.

The relationship between aggressive handling of lean pigs, including the use of an electric prod, and subsequent behavioral and physiological responses was studied to develop methods for simulating conditions which may result in non-ambulatory (SUBJECT) pigs at slaughter plants. One-hundred eight barrows and gilts weighing approximately 120 kg were randomly assigned to groups of six for moving, loading and unloading in one of two handling treatments. In the aggressive handling treatment (AGGRESS), the handler moved the animals through a 300 m course, including a high loading ramp, with frequent use of an electric prod. In the gentle handling treatment (GENTLE), the handler proceeded at a moderate pace through the same course, except that the loading ramp was lower and a plastic cane was used in place of the prod. Groups were treated consecutively to avoid circadian and ambient temperature bias. The handler and pig behavior were documented using direct observation. The same handler conducted both treatments. Serum lactate, glucose, NEFA, CPK, BUN, ammonia, acetacetate and cortisol were measured immediately after handling. Heart rate (HR) and skin and rectal body temperatures (sTEMP, rTEMP) were measured pre, during and post handling. Subjective scores were recorded for indications of blotchy skin (SKIN), open mouth breathing (BREATH) and vocalization (VOCAL). Pigs wedged (STUCK) during handling were recorded as well as the dependent behavior SUBJECT (inability to move, higher rTEMP, blotchy skin). This study suggests that the AGGRESS treatment resulted in a significant increase in SKIN, BREATH and VOCAL during each of the observation points ($P < 0.001$). Analysis of pen means demonstrated a significant association between AGGRESS treatment and dependent variables sTEMP, rTEMP and HR. Serum lactate and glucose were higher ($P < 0.005$) in the AGGRESS treatment group. While eleven pigs were classified as SUBJECT pigs in AGGRESS, none were found in GENTLE. When individual SUBJECT pigs were compared with the remaining pigs of AGGRESS there were significant positive associations with dependent variables ammonia ($P < 0.05$) and STUCK ($P < 0.05$). The behavioral and physiological responses of the pigs provide strong indicators of the stress induced by aggressive handling.

Key Words: Swine, Handling, Subject animals

1153 Variation in Hen Vocalizations During Pre-hatch, Hatch and Post-Hatch. M.B. Woodcock*, M.A. Latour, and E.A. Pajor, *Purdue University, West Lafayette, IN 47907.*

Vocalizations between hens and chicks around the time of hatch are commonly reported for poultry kept in natural conditions. Commercial incubators do not presently include such sounds, which may result in a more asynchronous hatch than under natural conditions. Before this hypothesis can be tested a better understanding of the hens calls, and their function is required. Although the occurrence of vocalizations around the hatch has been previously reported, details regarding the frequency and duration of hen calls have not. The purpose of this study was to describe in detail the pattern of a hen's vocalizations around a natural hatch. Four hens were placed in pens and audio and videotaped each day, during a 16 h light period (0400 to 2000 h), for 30 d (20 d before hatch and 10 d after hatch). Hen vocalizations were quantified in detail during three periods: pre-hatch (48 h before hatch), hatch (0 to 24 h), and post-hatch (48 h after hatch). Of the 4 hens, only two hens became broody and vocalized. Hens vocalized less at pre-hatch than during the hatch ($p < 0.001$) or post-hatch ($p < 0.001$). The average call rates on the day of hatch and post-hatch did not differ. However, the daily

pattern of calls differed greatly. On the day of hatch, calling rate gradually increased over the 16 h period. In contrast, during the post-hatch period, hen calls increased quickly during the first nine h, and then declined dramatically. The amount of time spent calling changed over the duration of the 16 h period. Hens spent more time calling at hatch than pre-hatch ($p < 0.001$), and more time calling in post-hatch than hatch ($p < 0.05$). In summary, the hens called more and spent more time calling as incubation progressed through hatch. A better understanding of parent - offspring communication during hatching may lead to beneficial applications to the commercial poultry industry.

Key Words: Poultry, Vocalization, Incubation

1154 The relationship between physiological parameters and behavioral response to social stress among three genetic lines of laying hens. R. Freire*², P. Singleton¹, Y. Chen¹, M.W. Muir², Ed. Pajor², and H.W. Cheng¹, ¹USDA-ARS, Livestock Behavior Research Unit, ²Dept of Animal Science, Purdue University.

Two genetic lines of White Leghorn hens have been selected for high (HGPS) and low (LGPS) group productivity and survivability resulting from cannibalism and flightiness. Different behavioral patterns induced by heat and cold stress have been reported between the selected HGPS line and a commercial Dekalb XL (DXL) line. The aim of this study was to examine differences in the behavioral response to social stress among the three genetic lines and relate these differences to physiological variables that were reported previously. Twenty hens from each of the three genetic lines were paired to form 3 mixed line combinations and kept in cages from 17-wk to 24-wk of age. Activities were recorded from video using instantaneous sampling at 1-min intervals for 30 min and continuous recording of aggressive pecking in a 10 min period started at 0800 daily. No evidence was found that the three genetic lines differed in dominance status ($P > 0.1$ for 3 combinations) or attack latencies ($P > 0.7$). The HGPS hens spent less time pecking at the feathers or body of another hen (damaging pecking) than LGPS hens ($P < 0.05$). In addition, pecking at the cage (cage pecking) was lower in HGPS and LGPS hens than in DXL hens ($P < 0.01$). The differences in damaging pecking could not be explained by variation in physiological variables ($P > 0.2$), but a large proportion of the variation in cage pecking ($r^2=59\%$) among the lines ($P < 0.001$) was explained by physiological variables, such as its unique alterations of heterophil/lymphocyte (H/L) ratio and corticosterone levels reported previously. In conclusion, the lower damaging pecking and cage pecking in HGPS hens may be related to their

lower social stress in 2-hen cages when compared to the other two lines. The data suggests that the genetic lines could be used as animal models for stress physiological observations.

Key Words: Social stress, behavior, Genetic selection, chickens.

1155 Stress induced alterations of IgG concentrations and hematological parameters in genetically selected chicken lines. Y. Chen*¹, P. Singleton¹, M.W. Muir², and H.W. Cheng¹, ¹USDA-ARS, Livestock Behavior Research Unit, ²Dept of Animal Science, Purdue University.

Two genetic lines of White Leghorn hens were selected for high (HGPS) and low (LGPS) group productivity and survivability resulting from cannibalism and flightiness. The aim of this study was to examine whether the selection alters the hens' immunity and hematology differently in response to social stress. At 17-wk of age, hens were randomly assigned into single- and 2-hen cages. The 2-hen cages contained one hen from HGPS or LGPS and one from a commercial Dekalb XL line that was used as standardized genetic competitor. At 24-wk of age, blood samples were collected from 70 hens (10 hens from 3 line, 2 replicates, plus 10 extra testers). Blood smears were prepared and stained with Wright's stains. A differential leucocyte count was collected from 200 leukocytes per hen. Concentrations of plasma IgG were quantified using ELISA. In single-hen cages, compared to HGPS hens, LGPS hens had a greater heterophil/lymphocyte (H/L) ratio ($P < 0.01$). In addition, LGPS hens had a greater number of eosinophils ($P < 0.01$). However, there was no difference in the concentrations of IgG between HGPS and LGPS hens. In 2-hen cages, when compared with these same lines in the single-hen status, LGPS hens exhibited a heterophilia, and a greater ratio of H/L ($P < 0.01$). In addition, although both HGPS and LGPS hens had an eosinophilia in 2-hen cages, a more intense increase was found in LGPS hens ($P < 0.001$). In contrast, HGPS hens had a greater increase in the concentrations of IgG in 2-hen cages vs. single-hen cages ($P < 0.01$). The data indicates that the immunity and hematology were differently regulated by the selection in the HGPS and LGPS lines. The changes of these physiological parameters in HGPS hens could be associated with their better adaptation to social stress that has been reported previously. Some of the parameters, such as ratio of H/L, eosinophilia, and IgG concentrations, could be used as an indicator of chicken well-being.

Key Words: Social stress, Plasma IgG and hematological parameters, Genetic selection, chickens.

ASAS/ADSA Ruminant Nutrition: Feed Additives, Rumen Fermentation, Minerals, and Transition Cows

1156 Use of exogenous enzymes from amylases from *Bacillus licheniformis* and *Aspergillus niger* in high-grain diets. R Rojo, G Mendoza*, S Gonzalez, R Barcena, M Crosby, and L Landois, *Colegio de Postgraduados*.

Two industrial amylases, alpha-amylase from *Bacillus licheniformis* and glucoamylase from *Aspergillus niger* were evaluated as exogenous enzymes in sheep fed high-grain diets. Amylolytic activity was compared with ruminal amylases at conditions of pH and temperature similar to the rumen. In situ DM digestibility of sorghum diets (79%) was measured at 12 h of ruminal incubation. Amylases were added to the sorghum (2.9 g enzyme/kg grain) before mixing the diet. Fifteen sheep were used in a completely randomized design (control, amylase or glucoamylase) and individually fed for 40 d. The highest activity (units/mg protein) was found ($P < 0.01$) in the amylase from *B. licheniformis* (4.1893) followed by the *A. niger* (1.9522) and ruminal fluid (0.0621). Addition of alpha-amylases increased in situ DM digestibility (%) at 12 h (control, 60.78), being greater with *B. licheniformis* (65.6) than *A. niger* (64.3). Intake was not affected by enzyme addition and no statistical differences were found in ADG (Control 238, *A. niger* 258, *B. licheniformis* 270 g/d), even when feed conversion numerically tended to be improved with the amylases (Control 4.59, *A. niger* 4.01, *B. licheniformis* 3.93 g/d). Despite the high amylolytic activity of the amylases and the improvements on in situ DM digestibility, no differences were detected in sheep performance.

Key Words: Enzymes, Grains, Starch

1157 Effect of direct-fed microbials supplementation on dairy cows fed nitrogen deficient diets and on *in vitro* bacterial growth. D. R. Ouellet* and J. Chiquette, *Dairy and Swine R&D Centre, Agriculture and Agri-Food Canada, Lennoxville, Canada*.

Eight rumen fistulated Holstein dairy cows (679 kg BW; SEM = 5) were used in a duplicated 4 x 4 Latin square design with a 2 x 2 factorial arrangement of treatments. Dairy cows were fed diets formulated to be adequate (CTL) or deficient (DEF) in metabolizable protein (MP; 12% less than requirements). The two diets were fed with or without direct-fed microbials (DFM) supplement (10 g /head/d of a mixture of *Aspergillus oryzae* and *Saccharomyces cerevisiae*). Total mixed ration (60:40 grass silage:barley based concentrate) was fed 12 times daily. Dry matter intake, milk production and composition were determined. The DFM mixture was also supplied, *in vitro*, to pure bacterial cultures in order to study the effect on bacterial growth rate. Given the high milk yield, both diets were estimated (NRC, 2001) to be deficient (10 and 14% less MP than requirements for CTL and DEF, respectively). Milk production averaged 40.3 kg/d and was not affected by the level of MP in the diets or by DFM. Dry matter intake tended to be lower for cows fed DEF (21.2 vs 22.9 kg/d, $P < 0.07$) resulting in a tendency ($P < 0.09$) to improve milk efficiency by 9%. Milk constituents (protein, fat and lactose) were unaffected by treatments. When supplied *in vitro*, the DFM mixture stimulated the growth of *Selenomonas ruminantium* ($P < 0.001$), *Streptococcus bovis* ($P < 0.02$) as well as some cellulolytic species such as *Butyrivibrio fibrisolvens* ($P < 0.02$) and *Fibrobacter succinogenes* ($P < 0.01$). On the other hand, DFM did not

affect the growth of *Ruminococcus albus* or *Ruminococcus flavefaciens*. In conclusion, except for bacterial growth *in vitro*, addition of direct-fed microbials to diets deficient in metabolizable protein had no effect on the *in vivo* parameters reported.

Key Words: Direct-fed microbials, Dairy Cattle, Protein Deficiency

1158 Exogenous amylases from *Bacillus licheniformis* and *Aspergillus niger* improve starch digestion but not performance of sheep. G Mora, R Barcena, G Mendoza, S Gonzalez, and J Herrera, *Colegio de Postgraduados*.

Two industrial amylases, alpha-amylase from *Bacillus licheniformis* and glucoamylase from *Aspergillus niger*, were evaluated as exogenous enzymes in sheep fed 50% sorghum grain (30% corn stover; 9% soybean meal; 9% molasses; 1% urea; 1% minerals). Enzymes were added at 2.1 g/kg sorghum, with three treatments: Control, amylase from *Bacillus licheniformis* and glucoamylase from *Aspergillus niger*. A metabolic trail was conducted using a 3 x 3 Latin Square design with 3 sheep (68 3.0 kg BW) fitted with ruminal and duodenal cannula. The same treatments were randomly allotted to 21 lambs (26 23.9 kg initial BW) individually fed during 60 days; a Completely Randomized Design with initial BW as a covariate was used. Ruminal starch digestion was lower ($P < .05$) in the control group (75.1%), as compared to exogenous enzymes (82.95% amylase; 87.2% glucoamylase); ruminal pH, ammonia-N or VFA did not change. No differences ($P > .05$) were found in total tract starch digestion. In the growing assay, enzymes did not change ($P > .05$) (kg/d; 1.16 control; 1.29 amylase; 1.19 glucoamylase), daily gain (g/d; 211 control; 231 amylase; 209 glucoamylase) or feed conversion. Although ruminal starch digestion was improved with exogenous enzymes, no differences were detected in sheep performance.

Key Words: Starch, Digestion, Enzymes

1159 Influence of monomer or dimer forms of isopropyl ester of HMB, on the supply of metabolisable methionine to the blood of ruminants. J.C. Robert*, C. Richard, and B. Bouza, *Aventis Animal Nutrition, Antony, France*.

In this experiment, three products were tested : HMBi(M) (2 hydroxy 4(mthyl thio) butanoic acid isopropyl ester), containing 99% of monomers ; HMBi(MD) composed of 57% of monomers and 40% of dimers and SmartamineTM M(Sm M) a methionine coated with a pH sensitive polymer based coating. Two non lactating rumen cannulated Holstein cows were used. Four treatments were given (4x one week periods) randomized between the two cows in a single dose : T1 : 65 g (M) ; T2 : 65 g (MD) ; T3 : 111 g (MD) ; T4 : 63 g Sm M. T4 was supplied at 1600h the first day (D1) for each experimental period and T1, T2 and T3 on D2 at 0800h. The animals were offered 10 kg/animal/day of a ration comprising 75% hay and 25% concentrate delivered in equal quantities twice a day. Blood samples were obtained on D2 of each experimental period at 0800, 0900, 1000, 1100, 1300 and 1500h and on D3 at 0800h. For T4, some additional blood collections were realized on D2 at 1800 and 2000h and on D3 at 0800, 1100 and 1500h to describe more completely the appearance of methionine in the blood. Blood plasma methionine concentrations (BPMC mg/100g) were measured on D1 at 1100h to establish base line values. Based on comparison of AUC and taking into account a reference value of 80% for bioavailability of methionine from SmartamineTM M , the bioavailability of methionine into the blood from an oral single dose was 44% for HMBi(M). Dimers did not show any methionine bioavailability.

Treatment	T1 (M)	T2 (MD)	T3 (MD)	T4 (Sm M)	SED	Source p<
HMBi monomer (g/animal)	64	37	64	0		
HMBi dimer (g/animal)	0	26	44	0		
Sm M	0	0	0	63		
Methionine Equivalent g*	49	49	83	49		
Base line BPMC (mg/100g)	0.35	0.37	0.34	0.32	0.02	NS
Net BPMC (mg/100g)**	1.55a	0.82b	1.26ab	1.31a	0.62	0.001
Net Area Under Curve**	26.6b	9.9c	26.1b	47.8a	4.5	0.05

*based on methionine equivalent concentration in M and MD : 0.77 ; in Sm M : 0.74. **discounting base line

Key Words: Methionine, Bioavailability, Chemical derivative

1160 A blood kinetics methodology to measure bioavailability of rumen protected methionine sources for ruminants. J.C. Robert*, G. Etave, T. D'Alfonso, and B. Bouza, *Aventis Animal Nutrition, Antony, France*.

This experiment was designed to describe the relationship between spot digestible methionine supply and plasma methionine response in terms of Area Under the Curve (AUC). Four non lactating rumen cannulated Holstein cows were randomly assigned to four treatments in a latin square design (4x1week periods) . The four treatments comprised four levels of SmartamineTM M - a methionine coated with a pH sensitive polymer based coating : T1 : 7.1, T2 : 17.8, T3 : 28.6 and T4 : 39.3 ; all values relate to estimated intestinal available methionine(g/day). SmartamineTM M was supplied through the rumen cannula into the rumen liquid phase at 1600h on the first day (D1) of each experimental period. The animals were offered 10 kg/animal/day of a ration comprising 75% hay and 25% concentrate delivered in equal quantities twice a day. Blood samples were obtained on the second day (D2) of each experimental period, every two hours, starting at 0600h for the first eight samples and thereafter every four hours from 0600 until 1800h for D3 and D4. Blood plasma free methionine concentrations (BPMC mg/100g) to determine base line values were measured on D1 at 0900, 1100 and 1500h. The best relation between AUC(Y) and quantity of digestible methionine (X :g) was described by the exponential equation: $Y = - 15.937454 (1 - \exp(0.038261 X))$ (SED=0.57). The objective, in the future, is to use this equation as a calibration to calculate the bioavailability of different sources of rumen protected methionine.

Treatment	T1	T2	T3	T4	SED	Dose p<
Smartamine TM M supply (g/animal)	12	30	48.2	66.4		
Digestible Methionine* (g/animal)	7.1	17.8	28.6	39.3		
Base line BPMC (mg/100g)	0.38	0.38	0.36	0.35	0.02	
Net** Max. BPMC	0.23a	0.69ab	1.18b	2.25c	0.25	0.0009
Net**Area Under Curve	4.71a	16.3ab	31.0b	55.8c	6.2	0.0008

*based on methionine concentration in SmartamineTM M : 0.74 and bioavailability 0.80 **discounting base line

Key Words: Methionine, Bioavailability, Methodology

1161 Effect of live yeast versus yeast culture on milk yield and related parameters in early lactation cows. G. Higginbotham*¹, J. Merriam², E. DePeters³, and J. Sullivan⁴, ¹University of California Cooperative Extension, Fresno/Madera Counties, ²University of California Cooperative Extension, Stanislaus/Merced Counties, ³University of California, Davis, ⁴Nutrius/Bioproducts, Kingsburg, CA.

Live yeast and a yeast culture were compared in the diets of lactating cows. Two pens of early lactation Holstein cows on a commercial dairy farm, each totaling approximately 200 cows, were used to investigate effects of supplementing their diets with a feed additive containing

live *Saccharomyces cerevisiae* yeast (BIOY) or an additive containing fermentation products produced from a yeast culture (YC). Pens were similar in cow composition for parity and averaged 100 days in milk at the start of the study. Experimental design was a crossover with two 4-week periods. Both treatment pens were fed a mixed ration 2x daily composed of alfalfa silage, alfalfa hay, flaked corn, whole cottonseed, corn distillers, almond hulls, wheat millrun, soybean meal, mineral mix, molasses, animal fat and EnerGII[®]. Both feed additives were fed once daily in the TMR. The BIOY group received 114g/cow/day of BIOyeast[®] which provided 4g of Procreatin-7[®] (SAF Products, Minneapolis, MN), or 60 billion live CFU. The YC group received 114g/cow/day of Diamond V yeast culture[®] (Cedar Rapids, IA). Cows were milked three times daily and housed in freestalls with access to an open dry-lot. Milk yield and composition were recorded by measuring milk weights from two milkings for three consecutive days during the last week of each period. Daily feed intake as well as feed refusal were measured on a pen basis using the EZfeed[™] feed management program Adjusted mean production per cow for the complete trial, based on milk measurements at the end of each period, was not different and averaged 44.2 and 44.5 kg/d (milk) and 43.6 and 43.5 kg/d (3.5% FCM) for BIOY and YC groups respectively. No difference in percentages of milk fat, protein, lactose and SNF occurred. Rumen fluid pH, total VFA concentration and blood urea N as measured from 8 cows per treatment were unaffected by treatment. Dry matter intake, which was measured on a pen basis, was similar. Results suggest that similar milk production responses can be achieved by feeding either live yeast or the metabolites produced from a yeast fermentation process.

Key Words: Yeast, Yeast culture, Milk production

1162 Milk production effects of a mycotoxin binder in diets with normal levels of contamination. A. Garcia^{*1}, M. L. Cuevas¹, G. A. Loarca², C. Landetta³, and R. A. Patton⁴, ¹Instituto Tecnológico y de Estudios Superiores de Monterrey, Queretaro, Qro/Mexico, ²Universidad Autónoma de Queretaro, Queretaro/Qro/Mexico, ³Grupo Karluis, Queretaro, Qro/Mexico, ⁴Nittany Dairy Nutrition, Mifflinburg, PA/USA.

We investigated the effect of inclusion of a specific mycotoxin binder (Mexsil^{MR}, Grupo Karluis) on the milk producing ability of dairy cows fed low levels of dietary mycotoxins. Cows were divided equally into 2 treatment groups based on milk yield and parity. They were fed TMR and were milked 2X per day for 12 periods of 2 weeks each. Dietary treatments consisted of the normal diet and normal diet plus 125 g of mycotoxin binder. Feed samples were submitted to a laboratory for nutrient and mycotoxin analysis. Corn silage and TMR were screened for aflatoxin, zearalenone, deoxynivalenol (DON), fumonisin and T-2 toxin using commercial kits. Milk production and milk components were determined biweekly. Health and reproduction data were recorded. Statistical analysis was performed using Proc Mixed of SAS with pretreatment production variables used as covariates. Factors in the model were diet, parity, period and BST. TMR samples had greater mean concentration of mycotoxins than did corn silage samples except for zearalenone. Mean mycotoxin levels in the TMR across the study were below accepted tolerances. However, mycotoxin concentration was not constant due to SE of about 100 percent. Mean biweekly T-2 levels were elevated in periods 6 and 8. Total mycotoxin levels were elevated in periods 6, 8 and 10. Milk production of control cows declined in periods of higher mycotoxins. SCC and BCS were improved overall for binder treated group. Mean production response to feeding mycotoxin binder for 12 weeks is presented below. We conclude that when feed levels of T-2 are in excess of recommended even for a short time, inclusion of this mycotoxin binder will lessen production decreases.

Variable	Units	-Binder	SE	+Binder	SE	Significance
Milk Yield	kg	34.8	.83	35.2	.85	Treatment*Period<.05
Protein	%	3.08	.01	3.08	.01	ns
Fat	%	3.58	.05	3.56	.05	ns
Log SCC		1.67	.06	1.50	.07	.05
BCS		2.80	.02	2.88	.02	.01

Key Words: Mycotoxins, DON, T-2

1163 Milk production in Holstein cows supplemented with different levels of ruminally protected methionine. A. Lara^{*1}, G.D. Mendoza², R. Barcena², C.M. Garcia², and L. Landois², ¹Universidad Autónoma Chapingo, ²Colegio de Postgraduados.

The effect of different levels of ruminally protected methionine (RPMet) were studied in lactating cows. Forty multiparous Holstein cows were fed a basal diet (18.8% CP, 35% ruminal degradable protein, and 1.7 Mcal kg-1 Enl) with alfalfa, corn silage and concentrate (48% forage: 52% concentrate). After calving, cows were randomly assigned to the treatments, which consisted in four levels of RPMet: 0, 8, 16 and 24 g d-1 of MepronM85 (Degusa Co.). Milk production and composition were measured over 120 d postpartum. Body weight and condition score, DM intake and milk production were measured each 15 d (3 consecutive days) starting on day 5 post-partum. Milk samples were also collected (07:00 and 18:00 h). Data were analyzed with the repeated measures (four treatments in 8 periods through lactation). No treatment effects (P>.05) were detected on DM intake (25.48 ± 2.51 kg d-1), body weight (599.78 ± 19.78 kg), body condition score (2.51 ± 0.19 units) and milk fat. However, milk production and protein were increased with addition of RPMet (P<.01). Cows supplemented with 8, 16 and 24 g of RPMet produced 2.2, 4.4 and 2.3 kg d-1 of more milk above the control, whereas milk protein output was increased by 93, 158 and 72 g d-1, respectively. Milk production responded quadratically (P<.05) to methionine level (Y = 31.11 + 0.5354 X + 0.0175 X²), with the maximum milk production estimated with 16.2 g d-1 RPMet. Results indicated that Holstein cows with a mean of 35 kg d-1 milk, will require addition of ruminally protected methionine (16 g d-1) to improve milk production.

Key Words: Methionine, Milk production, Milk composition

1164 Enzymic release of reducing sugars from oat hulls by cellulase, as influenced by a synergistic interaction between *Aspergillus ferulic acid esterase* and *Trichoderma xylanase*. P. Yu^{*1}, J.J. McKinnon¹, D.D. Maenz¹, V.J. Racz^{1,2}, and D.A. Christensen¹, ¹Department of Animal and Poultry Science, University of Saskatchewan, Canada, ²Prairie Feed Resource Centre Inc., Canada.

High amounts of hydroxycinnamic acids, mainly *p*-coumaric (PCA) and ferulic (FA) acids, are believed to be inhibitory to oat hull biodegradability by rumen microorganisms. Previous studies have shown that a novel enzyme - *Aspergillus ferulic acid esterase* (A-FAE) and *Trichoderma xylanase* (T-XYL) act synergistically to break the ester linkage between FA and the attached sugar of feruloyl-polysaccharides, releasing FA from oat hulls. We examined maximum enzymic release of reducing sugars from oat hulls with particle size of 250 µm by the action of individual enzyme alone (A-FAE at 4678.4 U/assay; cellulase at 22 levels, ranging from 0 to 2772.7 U/assay; T-XYL at twenty-two level, ranging from 0 to 4096 U/assay) and by the action of cellulase at six levels (6.3 mU, 2 U, 16 U, 128 U, 1024 U and 2772.7 U/assay), as influenced by a synergistic interaction between A-FAE (13 mU/assay) and T-XYL (1 U or 256 U/assay). Total acid-extractable reducing sugars in the oat hulls used in this study were 793.8 µg/mg. The results show that after a 24 h incubation with A-FAE alone, no reducing sugars were observed to be released from oat hulls. With cellulase alone, as the concentration increased from 0 to 2772.7 U/assay, the release of reducing sugars increased (P<0.01) from 0 to 39% with the highest release of reducing sugars at 512 U/assay. With T-XYL alone, as the concentration increased from 0 to 4096 U/assay, the release of reducing sugars increased (P<0.01) from 0 to 33% with the highest release at 2048 U/assay. When incubated together with T-XYL (1 U or 256 U/assay) and A-FAE (13 mU/assay), cellulase (6.3 mU-2772.7 U/assay) significantly increased (P<0.01) release of reducing sugars from 8 to 68%. These results indicate that the synergistic interaction between A-FAE and T-XYL on release FA from feruloyl-polysaccharides could make the remainder of the polysaccharides open for further hydrolytic attack and facilitate the accessibility of the main chain of polysaccharide to cellulase. This action extends the cell wall hydrolysis, thus releasing a higher yield of reducing sugars. Such enzymic pre-treatment of oat hulls may provide a unique advantage to rumen microorganisms for the biodegradation of the complex cell wall of oat hulls.

Key Words: Reducing sugars, Synergistic interaction, Oat hulls

1165 Effects of exogenous enzymes on fiber degradation of corn stalks. G. Tirado-Estrada¹, I. Mejia-Haro¹, C.R. Cruz-Vazquez¹, G.D. Mendoza-Martinez², I. Tovar-Luna³, and J. Fajardo-Pea¹, ¹CIGA ITA de Aguascalientes, Mexico, ²Colegio de Posgraduados, Texcoco, Mexico, ³URUZA- UACH.

To evaluate effects of corn stalks treated with exogenous fibrolytic enzymes on digestibility and ruminal fermentation, a study was carried out in three experimental phases: I, IVDMD; II, in situ DM digestibility (ISDMD); and III, ruminal fermentation patterns. In phase I the effect of the enzyme concentration (E) was evaluated: 0 (control), 1.5 and 3 g kg⁻¹ with three application methods of the enzyme: 1) dry (DE); 2) dry + 250 ml of water (DE+W); and 3) in a solution of 500 ml of water (SE). Treatments were: 0 enzyme (T0; control), 1.5 g of DE (T1), 3 g of DE (T2), 1.5 g of DE+W (T3), 3 g of DE+W (T4), 1.5 g of SE (T5), 3 g of SE (T6). In Phase II, four enzyme levels were used: 0, 1, 2 and 3 g kg⁻¹, two treatment times of corn stalks (0 h = T0 h and 24 h = T24 h), and two forage:concentrate rates, 82:18 (DI), and 73:27 (DII). In Phase III, the effect of the four enzyme levels on digestibility was evaluated on six sampling times 0, 3, 6, 9, 12 and 24 h after the application of the enzyme. Data were analyzed by ANOVA using the GLM of SAS (1985). IVDMD was affected ($P < 0.06$) by enzyme application. T1 was higher ($P < 0.05$) than T0, T4, T5, and T6. ISDMD and residual NDF disappearance (NDFR) of corn stalks were affected ($P < 0.01$) by the E level due to type of diet and E x T and T x D interactions. Treatments with exogenous enzymes had greater values ($P < 0.05$) of ISDMD than the control, and using 1g of E to 24 h presented the highest value ($P < 0.05$). No differences ($P > .05$) were produced by enzyme level on the degradation of ADF. DI was higher ($P < .01$) than DII in both IVDMD and NDFR. In the reduced model (data of DI; 4 x 2) treatment of 1 g of E to T24 h was greater than the rest of the treatments ($P < 0.05$) for ISDMD and NDFR. Quadratic and cubic trends in the complete experiment (Factorial 4 x 2 x 2) were shown for ISDMD and NDFR by enzyme effects and also in the E x T to 24 h interaction ($P < 0.01$). The greatest concentration of total VFA was obtained with 1 and 2 g of E at 3 and 9 h of sampling ($P < 0.05$), and propionate was increased at 1 g of E ($P < 0.05$). The highest concentration of N-NH₄ was reached with 1 and 2 g of E at 3 h ($P < 0.05$). Results indicated exogenous fibrolytic enzymes affect digestibility and fermentation of corn stalks.

Key Words: Fibrolytic, enzymes, Fiber

1166 Effects of an acetyl esterase containing preparation produced by a ruminal fungal isolate on *in vitro* ruminal fermentations. J. M. Tricarico*¹ and K. A. Dawson², ¹University of Kentucky, Lexington, KY, ²Alltech Biotechnology Inc., Nicholasville, KY.

An anaerobic fungus was isolated from the rumen of a steer fed a fescue hay-based diet and was grown anaerobically to produce a crude acetyl esterase containing enzyme preparation. This preparation did not contain measurable amounts of cellulase or xylanase activity. A series of studies were then performed to examine the effects of this enzyme preparation on *in vitro* digestion of a fescue hay-based diet by ruminal microorganisms. Batch cultures, established with rumen fluid from a steer fed the same diet, were used to examine the effects of supplemental acetyl esterase on *in vitro* VFA production. The effects of supplemental acetyl esterase on NDF digestion were examined using the Daisy^{II} *in vitro* incubation system and Ankom²⁰⁰ fiber analyzer (Ankom Technology Corp., Fairport, NY). After incubation at 39°C for 12 h, total VFA production and estimated hexose utilization rates were greater ($P < 0.05$) in cultures receiving the fungal preparation at 0.855, 2.85, 5.70, 8.55 and 11.4 units acetyl esterase/L than in control cultures. Acetyl esterase supplementation increased total VFA production mainly by enhancing ($P < 0.05$) acetate production without affecting the productions of propionate and butyrate except at acetyl esterase concentrations of 11.4 units/L. Total VFA production was greater ($P < 0.05$) in cultures receiving 1.14 units acetyl esterase/L than in control cultures as early as 2.5 h into the incubation. However, NDF digestibility after incubation for 3, 6, 9 or 12 h and the rates of total VFA production calculated for the period of time between 3 and 12 h of incubation were not different between cultures receiving 1.14 units acetyl esterase/L and control cultures. These results indicate that acetyl esterase containing preparations enhance ruminal *in vitro* fermentation of feed and may have an impact on ruminant performance.

Key Words: Ruminants, Digestion, Esterases

1167 Contribution of an acetyl esterase containing enzyme preparation to the action of exogenous enzyme supplements for ruminants. J. M. Tricarico*¹ and K. A. Dawson², ¹University of Kentucky, Lexington, KY, ²Alltech Biotechnology Inc., Nicholasville, KY.

Two studies were performed to examine the effects of combining a fungal enzyme preparation containing acetyl esterase activity and a commercial enzyme supplement for ruminants (Fibrozyme, Alltech, Inc., Nicholasville, KY) on *in vitro* fermentation of feed by ruminal microorganisms. The addition of both enzyme supplements to 1-L ruminal-simulating continuous cultures fed a fescue hay-based diet increased DM digestibility (47.4 vs. 60.2 g, $P < 0.10$), total VFA concentrations (112.7 vs. 122.8 mmoles/L, $P < 0.05$), estimated hexose utilization (62.5 vs. 68.3 mmoles/L, $P < 0.05$) and ammonia concentrations (30.8 vs. 31.4 mmoles/L, $P < 0.05$). Concentrations of acetate, propionate and butyrate were 7.8, 10.8 and 11.7 % greater ($P < 0.05$) in cultures receiving the enzyme supplements than in control cultures, respectively. In addition, enzyme supplementation reduced the acetate to propionate ratio (3.47 vs. 3.37, $P < 0.05$) and the pH (6.92 vs. 6.86, $P < 0.05$). The concentrations of total anaerobic, lactic acid-utilizing and cellulolytic bacteria did not differ in enzyme supplemented and unsupplemented cultures. In the second study, gas production was used to examine the kinetics of digestion in batch cultures fed a fescue hay-based diet, or its water-insoluble fraction, in the presence and absence of supplemental enzymes. Cumulative gas production over a 24-h period was 14 % greater (44.4 vs. 50.7 mL, $P < 0.05$) in cultures receiving the enzyme supplements than in control cultures when the fescue hay-based diet was used as the substrate. The maximum rate of gas production was reached 2 h earlier in enzyme supplemented cultures than in unsupplemented cultures when the water-insoluble fraction from the fescue hay-based diet was used as the substrate. These studies indicate that exogenous enzyme supplements containing acetyl esterase activities enhance ruminal fiber digestion by reducing the time required to reach the maximum rate of fermentation of insoluble substrates in feed.

Key Words: Ruminants, Digestion, Esterases

1168 Intake and milk production of dairy cows fed lactic acid bacteria and mannanoligosaccharide. J. Gomez-Basauri*¹, M.B. de Ondarza², and J. Siciliano-Jones², ¹Alltech, Inc., Nicholasville, Kentucky, ²F.A.R.M.E. Institute, Homer, New York.

The objective of this 28-day study was to determine the effect of a supplement (27.27 g/d) containing strains of lactobacilli *Lactobacillus acidophilus*, *Lactobacillus casei*, *Enterococcus (Streptococcus) faecium* (Total lactic acid bacteria 1 billion CFU's/g) and mannanoligosaccharide (Bio-Mos[®], Alltech, Inc, Nicholasville, KY) on daily dry matter intake (DMI), milk yield, and milk component concentration. Study animals consisted of two groups of 100 cows on a commercial dairy farm. Each group had similar initial milk yield (39.2 Kg/day) and days in milk (DIM, 154 days). Prior to the start of the study, it was determined that no pen effect existed. Cows entering any group during the course of the study were paired on production and days in milk. The basal ration consisted of corn silage, alfalfa/grass hay crop silage, whey, and commercial feed blend. Total ration composition was 17.7% CP, 38% UIP, 37.5% NFC, 4.5% fat, 28% forage NDF, and 1.67 Mcal/Kg NE_l. Thirteen days of milk yield data were used for statistical analysis. Milk was sampled from each cow during one milking on one day during week 3 and week 4 and analyzed for milk components. Cows fed lactic acid bacteria and mannanoligosaccharide consumed 0.42 Kg less DM ($P < 0.03$) and produced 0.73 Kg/d more milk ($P < 0.06$). There was a significant treatment by date interaction ($P < 0.03$). Cows fed lactic acid bacteria and mannanoligosaccharide increased milk yields over time while control cows maintained constant milk yields.

	Treatment	Control	SE	P <
DMI (Kg/d)	24.56	24.98	0.13	0.03
Milk (Kg/d)	39.57	38.84	0.27	0.06
Milk Fat (%)	4.44	4.24	0.07	0.07
Milk Protein	3.04	3.02	0.02	NS

Key Words: Mannanoligosaccharide, Lactating Cows, Lactobacilli

1169 Effects of a commercial bacterial culture feed supplement on ruminal microorganisms. S. A. Martin*, *University of Georgia.*

The objective of this study was to examine the effects of a commercial bacterial culture feed supplement on growth and lactate production by mixed ruminal bacteria grown in batch culture. In addition, the effect of the feed supplement on the *in vitro* fermentation of ground corn or soluble starch by mixed ruminal microorganisms was investigated. When mixed ruminal bacteria were grown in medium that contained 2 g/L maltose, bacterial growth and lactate production peaked at 8 h and lactate was utilized over the next 22 h. Similar incubations were conducted using only the bacterial feed supplement and bacterial growth and lactate production peaked at 24 h and some lactate was utilized over the next 24 h. When mixed ruminal bacteria were incubated in the presence of the bacterial feed supplement, bacterial growth peaked after 8 h and lactate production peaked at 8 h and most of the lactate was utilized over the next 40 h. In 24 h ground corn fermentations by mixed ruminal microorganisms, 3.5 and 7 g/L of bacterial feed supplement decreased ($P < 0.05$) final pH and the acetate:propionate ratio, while 7 g/L decreased methane ($P < 0.05$) and butyrate concentrations and increased ($P < 0.05$) propionate and lactate concentrations. Similar treatment effects were observed in 48 h ground corn incubations except that the 7 g/L treatment increased ($P < 0.05$) butyrate concentration and no lactate accumulated. Fermentation of soluble starch in the presence of both concentrations of bacterial feed supplement for 48 h decreased ($P < 0.05$) final pH, hydrogen, methane, propionate, and butyrate and increased ($P < 0.05$) lactate. Collectively, these results suggest that the bacterial feed supplement alters the mixed ruminal microorganism fermentation.

Key Words: rumen, microorganisms, bacterial feed supplement

1170 Effect of forage level and fibrolytic enzymes on nitrogen digestion in beef cattle diets. M. Murillo, M.S. Vazquez, H.L. Castro, J.F. Sanchez, and M.A. Cerrillo*, *Universidad Juarez del Estado de Durango, Durango, Dgo. Mexico.*

Four Simmental bulls (550 ±45 kg BW) fitted with cannulae in rumen and duodenum were used in a 4x4 Latin Square design with a 2x2 factorial arrangement to evaluate the interaction of forage level (66 vs 33%) and fibrolytic enzymes (0 vs 15 g/d, Fibrozyme®) on ruminal digestion and post-ruminal nitrogen flow. There were no interactions between forage level and fibrolytic enzymes on ruminal digestion and post-ruminal flow of nitrogen ($P > .05$). However, low forage level in the diet increased intake and ruminal digestion of nitrogen, 12.5 and 10% respectively, ($P < .01$). The addition of fibrolytic enzymes to the diet affected neither ruminal digestion of nitrogen nor microbial efficiency ($P > .05$). However, low forage level increased microbial efficiency 9.7% ($P < .05$). Flow of feed and microbial nitrogen to the small intestine as well as post-ruminal and total tract digestion of nitrogen were not affected by the addition of enzymes to the diet ($P < .05$). High level of forage increased flow of feed nitrogen to the duodenum (28.3%, $P < .05$, whereas low forage level increased the flow of microbial nitrogen (14%, $P < .01$). These results indicate that the addition of fibrolytic enzymes to the diets evaluated in this study did not affect nitrogen digestion.

Key Words: Fibrolytic enzymes, Cattle, Nitrogen digestion

1171 The effect of monensin and bovine somatotropin on lactation performance and body condition score of dairy cows. L J Erasmus*¹, L C Coetzee¹, C H Hesse², and T E Spike³, ¹*Agricultural Research Council, Irene, South Africa*, ²*Elanco Animal Health, Bryanston, South Africa*, ³ *Elanco Animal Health, Indianapolis, IN.*

Monensin supplementation has been associated with an improved energy status in dairy cows resulting from an increased supply of glucogenic precursors in the form of propionate. Bovine somatotropin (bST) administration is known to prolong the period of negative energy balance experienced by cows during early lactation. This study investigated the effect of bST (somatitrove/500mg/14 d) administration (commencing d 60 or d 100), with or without monensin supplementation on the productivity of dairy cows. Sixty four Holstein cows (32 multiparous and 32 primiparous) were used in a completely randomized block design. All cows received an alfalfa-corn based total mixed ration (18.5% CP, 11.3 MJ ME/kg DM) supplemented with 16 ppm monensin from 3 wk

prepartum until 3 wk postpartum whereafter cows were blocked and assigned to treatments based on parity, milk production from d 15 to d 21, body weight, and body condition score (BCS). The four experimental treatments which were fed until d 240 postpartum were: 1) no monensin, bST d 60 (B60); 2) no monensin, bST d 100 (B100); 3) monensin plus, bST d 60 (MB60); 4) monensin plus, bST d 100 (MB100). Milk production varied from 31.3 kg/d (MB100) to 33.4 kg/d (B60) and did not differ among treatments ($P > 0.05$). Dry matter intake was higher for cows that received bST on d 100 compared to d 60, the effect being most pertinent amongst primiparous cows ($P < 0.05$). Monensin supplementation per se did not affect intake but tended to depress butterfat percentage ($P = 0.08$). Body condition score was significantly increased ($P < 0.05$) by monensin supplementation (2.60 vs 2.82); earlier administration of bST had no effect on BCS. Gross efficiency of milk production was increased ($P < 0.01$) by earlier bST administration; 1.43 vs 1.30 for cows administered with bST on d 60 and d 100 respectively. These data suggest that monensin can play a positive role in recouping BCS before the next lactation and earlier bST administration (d 60) can improve gross efficiency of milk production.

Key Words: Dairy cows, Somatotropin, Monensin

1172 Differential response of D- and L-Met free plasma in cows fed different sources of rumen protected Met. Mercedes Vazquez-Anon, David Parker*, and Julia Dibner, ¹*Novus International, Inc. St. Louis, MO.*

L-Met is the biologically active form of Met. D-Met can also be used as a Met source by the cell after its conversion to L-Met. In this study, the contribution of different Met sources to plasma D- and L-Met is evaluated. Five dairy Holstein cows were used in a 5 x 5 Latin Square design. Oral doses of 49 g of DL-Met (E), 56 g of Alimet® (A), 32 g of Smartamine (S), and 28 g of Mepron (M) were mixed with 454 g of corn meal and offered to cows for 4 days. On day 4, the dose remaining after 30 minutes was placed within the rumen under the mat layer. All doses were calculated to supply equivalent amount of Met to the animal. Blood samples were taken on day 4 at 0, 1.5, 3, 6, 9, 12 and 24 h intervals for analysis of total free Met. In addition, analysis of D- and L-Met was undertaken using a chiral column from samples of two of the cows fed A, S and M. The averaged total free Met concentration over time was 2.27a, 2.40a, 3.03b, 3.68c and 5.12d ug/ml (± 0.38) for control, E, A, M and S, respectively (numbers with different letter differed $P \leq 0.01$). A significant time by treatment interaction was observed ($P \leq 0.01$). Plasma Met concentrations peaked at 6, 12 and 12 h after feedings from cows fed A, S and M, respectively. The rapid appearance of Met in cows fed A is due to its faster ruminal clearance with the rumen liquid phase and partial absorption across the omasum prior to its arrival in the duodenum. Met from S and M is not absorbed until they reach the transporter systems in the small intestine. Distribution of D- and L-Met isomers differed among sources. Of the total plasma Met over the 24-h sampling period, 100 % was in the form of L-Met in cows fed A. In animals fed S, D- and L-Met contributed 52 and 48 % to the total plasma Met. In animals fed M, D- and L-Met contributed 50 % and 50 %, respectively. Differences in the peak response in plasma free Met concentration to rumen protected methionine sources can be partially explained by the contribution of D-Met to the plasma free Met pool in animals given M and S.

Key Words: Plasma, Methionine

1173 Effect of ruminally protected methionine and inert fat on milk production in primiparous Holstein cows. J Ayala*¹, G Mendoza², L Landois², A Ramirez³, and S Vega³, ¹*Universidad Autonoma Chapingo*, ²*Colegio de Postgradua-dos*, ³*Universidad Autonoma Metropolitana.*

The effects of two levels of ruminally protected methionine (RPMet) and inert fat were studied in lactating cows. Thirty two primiparous Holstein cows were fed with a basal diet with alfalfa, corn silage and concentrate (60% forage: 40% concentrate). After calving, cows were randomly assigned to the treatments in a completely randomized design with factorial arrangement (2 x 2), which consisted in combinations of two levels of RPMet: (0 and 20 g d⁻¹ of MepronM85; Degusa Co.) with inert fat (0 and 3.5% of DM). Intake was estimated with markers. Milk production was measured during the first 45 days post-partum. Milk samples were collected during lactation peak (07:00 and 18:00 h). Daily intake was (kg) improved with fat (control 18.9^b; Met 18.3^b; fat

19.3^{ab}; Met+fat 20.3^a). Milk production (kg/d) at lactation peak was lower ($P < .05$) in control group (17.0^a vs. Met 23.5^b; fat 24.7^b; Met+fat 23.9^b), with lower persistency. There were no interactions fat x Met; main effects on milk production (45 d post-partum) were: met 21.6^b; fat 19.32^{ab}; 16.0^a control. Milk fat (%) was increased ($P < .05$) with inert fat (control 2.89^a; Met 2.71^a; fat 3.22^b; Met+fat 2.78^a) whereas milk protein (%) was augmented with RPMet (control 2.61^a; Met 2.95^b; fat 2.58^a; Met+fat 2.84^b). There was a positive response in primiparous Holstein cows receiving ruminally protected methionine and inert fat.

Key Words: Methionine, Inert fat, Milk production

1174 **Ruminal degradability of different feeds in the presence of *Saccharomyces cerevisiae*.** G. Scaglia^{*1}, J.J. Williams¹, L.W. Greene¹, and N.A. Cole², ¹Texas A&M University Agricultural Research and Extension Center, Amarillo, ²USDA-ARS at Bushland.

Research from our laboratory has shown that feeding *Saccharomyces cerevisiae* (SC) to growing steers increased ruminal fluid pH and digestibility of certain nutrients. Therefore, the objective of this study was to determine the *in situ* dry matter disappearance (DMD) of grain and hay sources, and ruminal fluid pH in the presence of different yeast strains. Three ruminally-cannulated cows were individually fed either no yeast, 10 g of SC47 (BIOSAF; 8x10⁹CFU/g), or 5.3 g of P7 (PROCREATIN-7; 1.5x10¹⁰CFU/g) daily in a 3 X 3 Latin Square (LS) design. Each period of the LS consisted of a 12-day adaptation and 3-day data collection. Cows were fed 7.7 kg of a concentrate diet (80% corn grain, 10% cottonseed hulls, and 10% of a protein/vitamin/mineral supplement) using electronic Calan gate feeders. On day 13, 5 g of steam-flaked corn grain, wheat grain, milo, alfalfa hay, and low and high quality sorghum hay was introduced into the rumen contents using *in situ* digestion bags at 0, 24, 36, 40, 44 and 48 hours (3 replicates/feed/time). At 48 h, bags were removed and washed with hot water until rinse water was clear. Bags were dried at 60 C and weighed to determine DMD at the different times of incubation. On day 15, ruminal fluid pH was measured at 0, 2, 4, 6 and 8 h after feeding. Wheat grain was the most rapidly digested followed by corn grain and then milo. Alfalfa hay was the most rapidly digested among the forages, with both sorghum hays having similar ($P > 0.10$) DMD. Yeast had no effect ($P > 0.10$) on the rate or extent of the *in situ* DMD of grains or hays. The regression of indigestibility (1-DMD) did not indicate that yeast strains used in this study affected the DMD of grains or hays. Ruminal fluid pH (6.45, 6.47, and 6.30) was similar ($P = 0.16$) when cows were fed the control, P7, and SC47 diets, respectively. These data suggest that there was no effect of the yeast strains tested on the DMD of the grains or hays and on ruminal fluid pH.

Key Words: grains, hays, yeast

1175 **The effects of ethoxyquin on performance and antioxidant status of feedlot steers.** K. W. McBride^{*1}, L. W. Greene¹, N. K. Chirase¹, E. B. Kegley², and N. A. Cole³, ¹Texas A&M University System, Amarillo, TX, ²University of Arkansas, Fayetteville, AR, ³USDA-ARS, Bushland, TX.

The effect of dietary ethoxyquin (EQ) on antioxidant status, VFA status, feed conversion, ADG, and volatile N losses from manure were determined. Eighty feeder steers (219 kg) were purchased and transported to Fayetteville, AR. Steers were housed in 16 pens during a 42-d backgrounding period, and fed either a control diet or 150 ppm EQ (Agrado; Solutia Inc., St. Louis, MO). Pre-transit blood and ruminal fluid samples were obtained at 0700 on d 42 and steers were transported by truck to Bushland, TX that evening. On arrival (0600), steers were processed and allotted to 6 pens equipped with pin-pointer feeders or 2 bunk pens (10 hd/pen). Steers were fed either a control or 150 ppm EQ diet in a 2 x 2 factorial arrangement with pre-transit diet. Jugular blood was drawn on d 0, 28, and 87 post-transit. Weights were obtained at 28-d intervals, and rumenocentesis was performed on d 5 and 28 to determine ruminal fluid VFA. Samples of excreta were collected from pen surfaces on d 28 to determine NH₃ volatilization using an *in vitro* gas emission chamber. Steers fed EQ in Arkansas had lower ($P < 0.05$) serum vitamin E concentrations pre-transit than control steers (1.93 vs 2.23 µg/mL). Post-transit, steers that received EQ in Arkansas had higher ($P < 0.04$) vitamin E concentrations than control steers. Steers receiving EQ post-transit had greater vitamin A concentrations ($P < 0.03$) than control steers on d 28 and 87. Steers fed EQ consumed more ($P < 0.001$) feed

(8.58 vs 7.25 kg/d) for d 1 to 182, and subsequently had greater ($P < 0.05$) ADG (1.61 vs 1.45 kg/d). Butyrate and iso-valerate were the only VFA affected by treatment, post-transit. The excreta harvested from pens housing steers fed EQ had 37% greater ($P < 0.03$) NH₃ volatilization than control pens. These results suggest that adding ethoxyquin to a typical feedlot diet may increase ADG of feedlot steers, and may effect certain antioxidant concentrations during the receiving period.

Key Words: Steers, Antioxidant, Feedlot Performance

1176 **Effect of exogenous fibrolytic enzymes on the digestion of alfalfa hay and barley straw by cellulolytic ruminal bacteria.** Y. Wang^{*1}, T. A. McAllister¹, L. J. Yanke¹, K. A. Beauchemin¹, D. P. Morgavi¹, L. M. Rode², and W. Yang¹, ¹Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, ²Rosebud Technology Development Ltd., Lethbridge, AB.

The effects of exogenous fibrolytic enzymes on colonization and digestion of ground barley straw and alfalfa hay by *Fibrobacter succinogenes* S85 and *Ruminococcus flavefaciens* FD1 were studied *in vitro*. Particles 1.5-2.0 mm diameter were used in the study. The enzyme was a mixture of two preparations from *Trichoderma* spp., with predominant xylanase and β-glucanase activities. Substrates (100 mg) were incubated in 5 ml of medium containing 0, 28 or 280 µg/ml enzyme for 24 h at 39°C, then were inoculated with medium or 24-h bacterial culture (0.1 ml) and incubated for a further 48 h ($n = 4$). Substrate colonization (via scanning electron microscopy) and NDF disappearance were determined. Glucose was included in an additional set of controls to assess possible effects of reducing sugars (RS) in the enzyme, but RS were found not to affect colonization or NDF digestion. Both levels of enzyme and both bacteria were effective at digesting NDF from hay and straw. With both substrates, more NDF hydrolysis ($P < 0.01$) was achieved with enzyme at high rate than at low. Strain FD1 had a greater capacity ($P < 0.01$) to digest hay than did S85, but digestion of straw was similar ($P > 0.05$) between the species. Presence or amount of enzyme did not affect ($P > 0.05$) extent of hay digestion by S85. A synergistic effect ($P < 0.01$) of S85 and enzyme on straw digestion was observed with 28 µg enzyme/ml but not 280 µg/ml. Strain FD1 digested more ($P < 0.01$) hay and straw with high enzyme than with low or no enzyme, but the effect was additive rather than synergistic. Bacterial colonization of both substrates was enhanced by preincubation with enzyme. Included in the incubation medium, exogenous enzymes showed potential to improve fiber digestion by cellulolytic ruminal bacteria. Their efficacy was dependent on bacterial species and rate of application.

Key Words: Exogenous enzymes, Cellulolytic bacteria, Fiber digestion

1177 **Sources of non-protein nitrogen and the addition of *Sacharomyces cerevisiae* to sugar cane based diets for young bulls: Intake, digestibility, nitrogen balances and ruminal parameters.** E. S. Pereira^{*1}, A. C. Queiroz², S. C. Valadares Filho², L. F. Miranda³, and A. M. V. Arruda¹, ¹Universidade Estadual Oeste Parana, ²Universidade Federal Viosa, ³Universidade Federal Minas Gerais, Brazil.

The objective of the present study was to evaluate the effects of the non-nitrogenous sources and the addition of *Sacharomyces cerevisiae* to sugar-cane based diets on the intakes and the total and partial apparent digestibility of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), total carbohydrates (TC), neutral detergent fiber (NDF) and non- structural carbohydrates (NSC). The nitrogen balance and ruminal parameters were also evaluated. Four Holstein-Zebu young bulls rumen and abomasal fistulated were allotted to a 4x4 Latin Square design in a 2 x 2 factorial arrangement. The animals were fed with sugar cane based diets, supplemented with two nitrogenous sources (urea or poultry litter) and two daily *Sacharomyces cerevisiae* addition (0 and 10 g/animal). The indigestible neutral detergent fiber (NDFi) was used as a marker, to determine the total and partial apparent digestibility of the nutrients. The intakes of DM, OM, EE, TC, NSC was not influenced by the nitrogenous sources and by the *Sacharomyces cerevisiae* addition. The intakes of CP and NDF were higher for the diets supplemented by poultry litter. The coefficients of total digestibility of CP and EE were higher for diets with urea. The apparent total digestibility of DM, OM, TC, and NDF were not influenced by the nitrogenous sources and by the *Sacharomyces cerevisiae* addition. The ruminal pH linearly decreased for the diets supplemented with urea, and presented a quadratic behavior when to these diets were

added Sacharomyces cerevisiae. The ruminal ammonia concentrations presented a quadratic behavior, and the maximum estimated values of 16.90; 26.12; 18.48 and 14.40 mg/dL for the diets with sugar-cane and urea, sugar cane, urea and Sacharomyces cerevisiae; sugar-cane and poultry litter; sugar-cane, poultry litter and Sacharomyces cerevisiae, respectively.

Key Words: Bovine digestibility, Intake, Supplements

1178 Effects of Live Yeast Concentrates on the In Vitro Semi-Continuous Culture Fermentation of a High Concentrate Diet. J. J. Williams*, G. Scaglia, and L. W. Greene, Texas A&M University Research and Extension Center.

A semi-continuous culture fermentation system was utilized to examine the effects of live yeast concentrate on ruminal pH in vitro. The experiment was designed as a 6 X 6 latin square utilizing 5 different strains of live yeast concentrate including: L13 (1×10^{10} cfu), L30 (1×10^{10} cfu), L11 (1×10^{10} cfu), SC47 (8×10^9 cfu) and proceatin 7 (1.5×10^{10} cfu) yeast strains. Six fermentation vessels containing inoculum from a ruminally fistulated cow were fed a high concentrate diet for 6 periods of 14 d. Each vessel was fed 7.5 g of diet containing a specific live yeast concentrate 3 times daily at 8 h intervals. Each canister was flushed with carbon dioxide (CO_2) to maintain anaerobic conditions. All fermentors were maintained in a circulating heated water bath kept at a temperature of 39C. Standard McDougall's artificial saliva was utilized as a buffer at a flow rate of .56 ml per min. Yeast treatments were included in each of the diets based on equal quantities of colony-forming units (cfu). After a 2 d adjustment period all fermentors were fed their respective diets for 12 d. On d 10 and 11 pH of the inoculum was measured every 2 h for 8 h. On d 12 samples were taken every 2 h for 8 h. All samples were immediately placed in a -20C freezer. During periods 1 - 5 of the experiment, the SC47 treatment displayed pH values less than ($p < .05$) control. There were however no differences among any treatments when all periods were combined. The pH data for the L11 treatment also displayed values that were consistently less than ($p < .05$) control, however, again no difference overall was determined among any treatment. Although none of the yeast treatments displayed a significant ($p < .05$) increase in pH above control, the L13 and L30 yeast treatments did show a consistent numerical increase over the pH values of all other treatments.

Key Words: Continuous Culture, pH, yeast

1179 Use of gas production technique to estimate the rate and extent of starch degradation from starchy feedstuffs in rumen fluid. Weizhong Chai¹, A. H. van Gelder¹, and J. W. Cone¹, ¹ID TNO Animal Nutrition, Institute for Animal Science and Health, The Netherlands.

Abstract Gas production (GP) and starch degradation (STAD) from starchy feedstuffs were measured simultaneously by in-vitro incubation in buffered rumen fluid after 0, 4, 6, 8, 12, 16 and 24 h incubation to explore the possibility to estimate STAD via GP technique for starchy feedstuffs. The results showed the ranking in the initial degree of starch degradation and gas production. Potato starch and maize had the slowest initial rate, and tapioca, corn cob mix and barley had the fastest ones in STAD. Starch degradation of Over 75% took place after 6-h incubation and nearly finished completely in 24-h incubation. Potato starch and maize, likewise, had the slowest initial rate of gas production, and however the fastest initial rate was found in the samples with smallest total starch content (TSC) such as pea and barley. Gas production was in line with the starch degradation, but the linking degree between GP and STAD varied with the samples with different TSC, especially in the initial incubation. Overall regression indicated a strong correlation between GP and STAD with R2 0.88 and for individual sample, R2 ranged from 0.93 1.00. The regression relationship was affected by TSC of the sample. A larger TSC displayed a higher coefficient and constant as well. R2 for the constant and coefficient regression with TSC was 0.88 and 0.91 respectively. The multiple linear regression was made via TSC and GP as two main predictors: $\text{STAD} = -318.14 + 0.427 * \text{TSC} + 1.876 * \text{GP}$ ($R^2 = 0.95$, $\text{RSD} = 48.71$, $P = 0.0000$). The estimation equation was further modified by using GP as main predictor and its constant and coefficient was, however, indirectly estimated by incorporating the regressions of constant and coefficient with TSC instead of direct estimation: $\text{STAD} = (0.2088 * \text{TSC} + 168.55) + \text{GP} * (0.00136 * \text{TSC} + 0.9654)$ ($R^2 = 0.97$,

$\text{RSD} = 41.2$, $P = 0.0000$). R2 and RSD in both equations were well improved if compared with the values of 0.88 and 76.15 of the regression using GP as unique predictor. The much higher in R2 and RSD of the second equation indicated the modified equation was more accurate and robust. Gas production technique can be used to estimate the rate and extent of starch degradation in rumen fluid, as long as the starch content is taking into account.

Key Words: Gas production, Starch degradation, Rumen fermentation

1180 The effects of substrate, ammonia and pH on gas production and starch degradation from starchy feedstuffs in buffered rumen fluid. W. Z. Chai¹, J. W. Cone^{*1}, A. H. van Gelder¹, and A. A. Kamman¹, ¹ID TNO Animal Nutrition, The Institute for Animal Science and Health, The Netherlands.

Abstract Three experiments were conducted to evaluate effects of pH, substrate and ammonia levels on starch degradation (STAD) and on gas production to look into the optimal conditions for GP technique in starchy feedstuff evaluation. The pH effect on STAD of six starchy samples was studied by using phosphate buffer mixed with rumen liquor in 24-h in-vitro incubation. The results indicated pH 5 adversely affected STAD and no significant differences were found among pH 7, 6 and 5.5, even though STAD appeared larger at pH 6. The ranking in STAD degree of the starchy feedstuffs was found in vitro degradation with rumen fluid at all pH levels. Barley, wheat and tapioca showed the highest STAD and potato starch and maize the lowest in STAD at each pH level. Minimum STAD took place in first 4-h incubation. Substrate level did not affect total GP (g-1OM), but influenced total GP per incubated bottle. On the other hand, substrate concentration significantly affected the shape of gas curve. Increased substrate reduced the time to reach the half-maximal gas production and curve sharpness. Thus substrate concentration affected the fermentation rate, and higher increased substrate concentration increased GP rate in the OM range of 100 500mg substrate. Ammonia carbonate concentration (ACC) did not affect total GP (g-1OM) in such starchy feedstuffs, but it affected the shape of GP profile. GP rate was improved with the increase of ammonia carbonate in the buffer. GP rate of 0.0 ACC was significantly slow from those of other ACC. Though GP rate of 1.0 ACC was the fastest, but no significant differences were found among ACC levels of 1.0, 1.5 and 2.0 in GP rate. The finding from this study proved pH 6.9, 1.0g ACC and 400mg substrate in buffered rumen fluid, the condition of media was currently used in ID-Lelystad, were appropriate in GP technique for the STAD evaluation of starchy sample. These experiments emphasize the need for standardization of GP technique to facilitate the comparison of results among the samples and laboratories. This need will be extreme when GP is used for feed evaluation. The sensitiveness in GP rate and extent among starchy samples imply the great potential and accuracy of GP technique in evaluating the characteristics of different starchy feedstuffs.

Key Words: Gas production; Starch degradation; Substrate; Ammonia; pH; Rumen fermentation; In vitro

1181 Splanchnic first pass sequestration of acetate absorbed from the washed reticulo-rumen of dairy cows. N. B. Kristensen*, Danish Institute of Agricultural Sciences, Tjele, Denmark.

The present study was undertaken to investigate the sequestration of acetate in the reticulo-ruminal epithelium and liver of dairy cows. Four ruminally fistulated Holstein cows yielding 15 to 25 kg milk/d were infused with 2-13C-acetate (6.2 ± 0.1 mmol/h) in a jugular vein and blood was sampled from the other jugular vein or V. epigastrica. The reticulo-rumen was emptied and washed in warm tap water and isotonic NaCl. The buffers incubated in the ru-men was bicarbonate buffered, adjusted to pH 6.8 and heated to 39C before administration. The experimental protocol was divided into 3 periods of intraruminal incubations: C1) 45 min with 20 l of control buffer without VFA, Exp) 180 min with 20 l VFA buffer and con-tinuous intraruminal infusion of VFA, and C2) 45 min with 20 l of control buffer without VFA. The isotopic composition of acetate was measured by gas/liquid chromatography - isotope ratio mass spectrometry. During the Exp period 4.55 ± 0.02 mole of acetate, 2.06 ± 0.01 mole of propionate and 0.42 ± 0.00 mole of butyrate were added to the rumen. During the Exp period the cows absorbed 2.87 ± 0.05 , 1.36 ± 0.01 , and 0.28 ± 0.00 mole of the acetate, propionate and butyrate, respectively. The irreversible loss rate (ILR) of acetate

(357 ± 32 mmol/h) was not different ($P = 0.3$) in period C1 compared with period C2 and this value was used as an estimate of acetate supply of non-ruminal origin. The ILR of acetate re-sponded promptly to the introduction of VFA buffer into the rumen. After 10 min of VFA buffer incubation the ILR had increased ($P < 0.001$) to the level maintained throughout the 180 min period (1115 ± 47 mmol/h). Of the acetate absorbed by the cows 20 ± 2 % did not enter the peripheral circulation. During VFA buffer incubations the splanchnic first pass se-questration of acetate was 193 ± 25 mmol acetate/h. These results show that the maximum possible acetate metabolism in the reticulo-ruminal epithelium under these experimental conditions is insignificant in relation to the ILR of acetate in a non-nutrient deprived cow.

Key Words: VFA, Metabolism, Dairy cows

1182 The effect of dietary roughage on rates of glucose, acetate and beta-hydroxybutyrate clearance from plasma in dairy calves. D.L.J. Benschop^{*1}, J.P. Cant¹, and R. Spratt², ¹University of Guelph, Guelph, Canada, ²Agribands Purina Canada Inc., Woodstock, Canada.

It has been suggested that the ability to utilize VFA post-absorptively occurs subsequent to the structural development and ability to produce VFA in the rumen. To test the effect of dietary roughage on post-absorptive utilization of glucose, acetate and beta-hydroxybutyrate (BHB), 24 male Holstein calves were stratified by liveweight at one week of age and randomly assigned to one of four dietary treatments (n=12) for a period of eight weeks. Treatments were a processed-grain control diet (CON), and three diets in which the grain was partially replaced by 10% roughage (10R), 20% roughage, or cracked corn (CC). Analyzed NDF levels in the CON, 10R and 20R diets were 18%, 20% and 23% of DM, respectively. Glucose, acetate and BHB clearance tests were carried out on weeks two, six and eight of age. Calves were weaned from milk replacer at week 5. BHB was injected through a jugular vein catheter as a bolus of 0.036 mmol/kg bodyweight (BW) at week 2 and 0.09 mmol/kg BW at weeks 6 and 8. Due to the fast rate at which BHB levels returned to baseline, blood samples were collected at -10, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15, 25 and 40 minutes post-injection. Glucose (2.78 mmol/kg BW) was infused over a 1-min period and samples were taken -10, 0, 5, 10, 15, 20, 25, 30, 45, 60, 90, 120 and 150 min after infusion. Sodium acetate (0.8 mmol/kg BW) was infused over a 3-min period and samples were obtained at -10, 0, 2, 4, 6, 8, 10, 15, 20, 25 and 30 min post-infusion. Baseline glucose concentration in plasma was not affected by treatment but increased from 4.5 to 6.2 mM between 2 and 8 weeks of age. Glucose clearance also was not affected by dietary treatment but increased from 3.42 to 4.39 ml/(min kg) between weeks 2 and 6. Plasma acetate concentrations increased as the calves developed and at week 8, acetate concentration in plasma was significantly increased to 0.15 mM on 20R compared to 0.09 mM on CON. Acetate clearance, however, was significantly lower at 21.4 ml/(min kg) on 20R compared to 48.4 on the CC diet. Acetate clearance was greatest at week 2. The increase in acetate concentrations in blood as the calves developed was due to an increased production of acetate in the rumen with no improvement in the capacity to utilize acetate post-absorptively.

Key Words: Roughage, Rumen, clearance

1183 Altering ruminal microbial colonization and synthesis by manipulation of dietary factors. W. Z. Yang^{*1}, K. A. Beauchemin¹, and L. M. Rode², ¹Agriculture and Agri-Food Canada, ²Biovance Technologies Inc..

Effects of dietary factors including kernel thickness of processed barley grain, ratio of forage to concentrate (F:C), and forage particle size on bacterial colonization of feed particles and distribution in the rumen, and duodenal flow of bacteria in dairy cows were evaluated. The experiment was designed as a double 4 × 4 Quasi-Latin square with a 2 × 3 factorial arrangement of treatments using eight lactating cows with ruminal and duodenal cannulas. Barley grain was steam-rolled to a coarse (1.60 mm) or flat (1.36 mm) thickness; ratio of F:C was low (35:65) or high (55:45); and forage particle size was long (7.59 mm) or short (6.08 mm). Cows were offered ad libitum access to a total mixed diet. Bacterial colonization was linearly increased ($P < 0.01$) from about 5 to 70% with decreasing size of rumen particles. The degree of colonization on each fraction of the rumen particulate matter as determined by sieving was only affected ($P < 0.10$) by ratio of F:C with consistently higher ($P < 0.10$) bacterial colonization for high than for low F:C ratio diets.

Concentration of solid associated bacteria (SAB) in duodenal digesta was greater ($P < 0.05$) than that of ruminal digesta. Of the total bacterial mass within the rumen, less than 20% was associated with the liquid (LAB) and with over 70% was associated with the small particles that passed through the 0.6-mm sieve. In general, bacterial distribution in the rumen was not influenced by dietary factors. While the bacterial pool in the rumen was lower ($P < 0.04$) when flatly rolled barley, rather than coarsely rolled barley, was fed, bacterial flow to the duodenum was greater ($P < 0.10$) with increasing F:C ratio. These results indicate that manipulation of dietary factors such as F:C ratio has the potential to alter bacterial colonization of rumen particles and the relative proportion of LAB to SAB, which were positively correlated to bacterial flow to the duodenum.

Key Words: Dietary Factors, Bacterial Colonization and Distribution, Microbial Protein Synthesis

1184 Metabolism of 2-13C-propionate in the rumen epithelium of sheep. N. B. Kristensen^{*1}, T. H. Steensen¹, S. G. Pierzynowski², and A. Danfr¹, ¹Danish Institute of Agricultural Sciences, Tjele, Denmark, ²Lund University, Lund, Sweden.

The aim of the present study was to estimate the contribution of ruminal 2-13C-propionate to the net portal flux of lactate in sheep fed barley based concentrate. Three rams (46 ± 2 kg BW) were fitted with silicone catheters in A. mesenterica, V. ruminalis and V. porta. During blood sampling the sheep were fed every hour and continuously intraruminally infused with water + 0.30 mmol/h of 2-13C-propionate (Trt0) or 20 mmol/h of propionate + 0.42 mmol/h of 2-13C-propionate (Trt20). Blood flow was measured using p-aminohippuric acid dilution. Concentration and isotopic composition of propionate, lactate and glucose were measured by gas/liquid chromatography - isotope ratio mass spectrometry. The contribution of ruminal 2-13C-propionate to the net portal flux of lactate was calculated from a balance equation with the assumption that no arterial lactate was metabolized in the portal drained viscera (PDV) and that lactate produced in the PDV was derived only from arterial glucose or ruminal propionate. The irreversible loss rate of propionate in the rumen tended to increase ($P = 0.06$) with Trt20 (81 ± 20 mmol/h) compared with Trt0 (71 ± 19 mmol/h). The relative enrichment of 13C in arterial lactate, portal lactate and arterial glucose compared with ruminal propionate was not affected by treatment ($P > 0.10$) and estimated as 21 ± 4, 22 ± 4 and 37 ± 4 %, respectively. The portal net flux of lactate (6 ± 1 mmol/h) was not affected by treatment ($P > 0.10$). In one sheep the 13C enrichment of lactate produced in the PDV was numerically lower than the 13C enrichment of arterial glucose. The contribution of propionate to the lactate flux in this animal was set to 0. The calculated conversion of ruminal propionate into portal lactate was 0.8 ± 0.4 % of the ILR of ruminal propionate and was not affected by treatment ($P > 0.10$). These results show that the amounts of ruminal propionate recovered as lactate in the portal vein is insignificant compared with the ILR of propionate in the rumen.

Key Words: VFA, Metabolism, Ruminant

1185 Validation of the Sulphur hexafluoride(SF₆) tracer gas technique in measuring methane and carbon dioxide production of cattle. D. A. Boadi^{*}, K. M. Wittenberg, and A. Kennedy, University of Manitoba, Winnipeg, Manitoba Canada.

Methane (CH₄) and carbon dioxide (CO₂) production from six crossbred yearling beef heifers (399.8 ± 12.8 kg) were measured for six days, using a SF₆ tracer gas technique (TRACER) and the open-circuit calorimetry hood method (CAL), to validate the former in estimating CH₄ and CO₂ production in the field. Animals were individually fed, 50% barley concentrate and 50% alfalfa cubes at 1.3x maintenance requirements daily. After feeding, 24 hr gas measurements were taken on three heifers by each method. The three heifers as a group, were switched on subsequent days between CAL and TRACER methods in an incomplete block design. Methane production ranged from 107.5 to 144.6 Ld⁻¹ (mean 129.6 ± 4.0 Ld⁻¹) on CAL, and 90.2 to 165.6 Ld⁻¹ (mean 136.7 ± 4.0 Ld⁻¹) on TRACER. The mean CH₄ production (Ld⁻¹) was not different ($P = 0.24$) between methods. In contrast, TRACER CO₂ production was 20% higher than CAL CO₂ production ($P < 0.01$). The range in CO₂ production was 1573.7 to 2048.7 Ld⁻¹ (mean 1892.4 ± 74.0 Ld⁻¹) by CAL and 1540.7 to 3330.2 Ld⁻¹ (mean 2353.5 ± 74.0 Ld⁻¹) by the TRACER method. Day to day variation in CH₄ production, was not different between methods ($P > 0.05$), however animal to animal variation (11.7%) was significant by TRACER method ($P = 0.04$) but not CAL method

($P = 0.53$). Comparison of the equality of variance between the two methods showed that there were no differences in variations ($P > 0.05$) between CAL and TRACER for CH_4 production. On the other hand, variations in CO_2 production was not equal ($P > 0.05$) between methods. It is concluded that the SF_6 tracer technique can accurately estimate CH_4 production, but not CO_2 production. The study implies that for field CH_4 measurements using the TRACER method, more animals are needed than CAL in order to reduce animal to animal variations.

Key Words: Methane and CO_2 measurements, SF_6 tracer gas technique, Validation

1186 Effect of pH and solid dilution rate on microbial fermentation and nutrient flow in a dual flow continuous culture system. M. Rodriguez, S. Calsamiglia*, and A. Ferret, *Universidad Autonoma de Barcelona, Spain.*

Eight dual-flow continuous culture fermenters (1320 mL) were used in two consecutive periods to study the effects of pH and solid dilution rates on microbial fermentation and nutrient flows using liquid (LAB) or solid (SAB) associated bacteria. Fermenters were fed continuously a 60 to 40 forage to concentrate ratio (17% CP, 29.3% NDF). Each period consisted in 7 days for adaptation and 3 for sampling. The last day of the experiment, LAB and SAB pellets were isolated from each fermenter. Fermenters were maintained at a constant temperature (38C) and liquid dilution rate (10% per h). Treatments were arranged in a factorial design, being pH (H = 6.4; L = 5.5) and solid dilution rate (S = 5, and F = 10 % per h) the main factors. No significant interactions were detected. Treatments L and F resulted in lower apparent DM, OM, NDF and ADF digestibilities. True digestibility of DM and OM were only significant in L and F when SAB were used for calculations. Total volatile fatty acids were lower in F vs S (61.4 vs 73.2 mM, respectively). At low pH, the concentration of propionate increased (25.4 vs 16.9 % for L and H, respectively) and that of acetate decreased (58.2 vs 64.9 %, for L and H, respectively). Solid dilution rate did not affect ammonia N concentration, but S increased dietary N flow, and reduced bacterial N flow, protein degradation and the efficiency of microbial protein synthesis when SAB were used. Similar results were obtained with LAB, but differences in dietary N flow and protein degradation were not significant ($P > 0.05$). Low pH reduced ammonia N concentration (10.8 vs 17.6 mg/100mL), but did not affect the efficiency of bacterial N synthesis or bacterial N flow. Dilution rate and pH affected microbial fermentation profile. However, results were different depending on the bacterial population selected for calculations. Acknowledgments: Financial support provided by Project CICYT AGF097/0444.

Key Words: Microbial fermentation, dilution rate, pH

1187 A dynamic mechanistic model of small intestinal starch digestion and glucose absorption in the dairy cow. J A N Mills*¹, L A Crompton¹, J Dijkstra², J A Maas³, C K Reynolds¹, and J France¹, ¹*The University of Reading, Reading, UK*, ²*Wageningen University, Wageningen, NL*, ³*University of Delaware, Delaware, USA.*

The high contribution of postruminal starch digestion to total tract starch digestion on certain energy dense diets demands that limitations to small intestinal starch digestion are identified. A dynamic mechanistic model of the small intestine was constructed and evaluated with regard to its ability to simulate published experimental data for abomasal carbohydrate infusions in the dairy cow. The seven state variables represent starch, oligosaccharide, glucose and pancreatic amylase in the intestinal lumen, oligosaccharide and glucose at the unstirred water layer (UWL), and the intracellular glucose of the enterocyte. Enzymic degradation of starch is a two stage process involving luminal pancreatic amylase and oligosaccharidase on the brush border of the enterocyte confined within the UWL. Na⁺ dependent glucose transport (SGLT1) into the enterocyte is represented along with a kinetically asymmetrical facilitative GLUT2 transport system on the basolateral membrane. The small intestine is subdivided into three main sections representing the duodenum, jejunum and ileum for parameterisation. Further sub-sections are defined between which there is a continual flow of digesta represented as a fractional rate. The model predicted non-structural carbohydrate disappearance for cattle unadapted to duodenal infusion with an $r^2 = 0.92$ and a root mean square prediction error (rootMSPE) of 25.4%. Simulation of glucose disappearance for mature Holstein heifers adapted to various levels of duodenal glucose infusion yielded an $r^2 = 0.81$ and a rootMSPE of 38.6%. Behavioural analysis identified the limitations

for small intestinal starch digestion efficiency at high levels of duodenal starch appearance. Limitations to individual metabolic processes, particularly to starch digestion in the proximal section of the intestine, can create asynchrony between starch degradation and glucose uptake capacity. The model indicated that there were a series of rate limiting steps in small intestinal starch metabolism including pancreatic amylase secretion, oligosaccharidase activity, and glucose uptake via SGLT1.

Key Words: Small Intestine, Dynamic Model, Dairy Cow

1188 Effect of rumen degradable protein and fiber quality on ruminal bacterial populations in continuous culture. D. L. Hastings*¹, K. E. Griswold¹, G. A. Apgar¹, S. A. Kocherginskaya², R. I. Mackie², and B. A. White², ¹*Southern Illinois University, Carbondale, IL*, ²*University of Illinois, Urbana, IL.*

The effect of rumen degradable protein and fiber quality on bacterial biodiversity was examined using dual-flow continuous culture. The experimental design was a 4 x 4 Latin square with a 2 x 2 factorial arrangement of treatments. Factors were level of rumen degradable protein and quality of fiber, and the treatments were: 1) high degradable protein (12% of dietary DM) with high quality alfalfa (HPHF), 2) high degradable protein (12% of dietary DM) with low quality alfalfa (HPLF), 3) low degradable protein (9% of dietary DM) with low quality alfalfa (LPLF), and 4) low degradable protein (9% of dietary DM) with high quality alfalfa (LPHF). Periods were 10 d with 7 d for equilibration and 3 d for sampling. Bacterial samples were collected from inoculum, and the fermentor vessels during each 3 d sampling period. Samples were separated into particle associated bacteria (PAB) and planktonic bacteria (PLB), and whole DNA was extracted. DNA was subjected to PCR amplification of the V3 hypervariable region of the 16s rRNA gene. The resulting oligonucleotides were separated using denaturing gradient gel electrophoresis (DGGE) to assess bacterial diversity in each sample. Data were analyzed using the GLM procedures of SAS. Results indicated that the bacterial diversity of samples from the 3 sampling days were 16.88 - 20.85% similar for PAB and 19.23 - 23.03% similar for PLB compared to the inoculum used in the system. There were no treatment effects on similarity of sample diversity to inoculum diversity ($P > .05$). Indices of similarity were calculated to determine if RDP or fiber quality would alter bacterial populations. There was a trend for treatments containing low quality fiber to select for more highly similar bacterial populations compared to high quality fiber treatments (50.4 vs. 31.7 for PAB and 32.1 vs. 15.0 for PLB, respectively) ($P = .085$). Level of RDP had no effect on similarity of bacterial populations. Altering dietary elements can cause changes in ruminal bacterial diversity in continuous culture.

Key Words: RDP, Fiber Quality, Bacterial Diversity

1189 Effects of an Inhibitor of Obligate Amino Acid Fermenting Bacteria upon Ruminal and Nutrient Utilization by Calves. E.L. Moody*¹, C.E. Cole¹, F.O. Carrette-Carron¹, W.C. Ellis¹, G. Wu¹, M.M. Kothmann¹, and R.J. Wallace², ¹*Texas A&M University*, ²*Rowett Research Institute.*

Deamination of amino acids in excess of that required by rumen microbes is nutritionally wasteful for the ruminant's tissues. Obligate amino acid fermenting bacteria account for most amino acid deamination and an inhibitor of these bacteria has been identified (Floret, et al., 1999 Appl. Environ. Microbiol. 65:3258-3260). The objective of this experiment was to investigate effects of LY29 upon ruminal and animal utilization. Effects of LY29 were determined during successive periods involving lagged ruminal additions of 0, 0.8, 1.6, 0 and 0 g/d of LY29/d to 12 cattle having rumen and duodenum cannula. The two levels of LY29 were evaluated in a mixed diet of 30% cottonseed hull and 70% concentrate diet (160g CP/kg DM). Each period consisted of a 9 d adaptation period and a 5 d period for collection of digestion data. Flux of nutrients to the duodenum was computed with reference to nutrient and indigestible NDF, IF, ratios at the duodenum and diet. Intake of diet DM was determined during d 7-14. Responses to 1.6 g LY29 are reported because most responses were not maximal for 0.8 g/d dose. For the mixed diet, responses to 1.6 g/d of LY29 vs. the control resulted in significant ($P < 0.05$) responses in feed intake (0.82), feed efficiency (1.15), rumen ammonia (0.45), M% of ruminal acetate (1.18), propionate (0.53), butyrate (1.24), isobutyrate (0.72) and valerate (0.73), duodenal flow of OM and IF (0.81) and duodenal flow of N (0.67). Rate of gain was not significantly affected by LY29. These results suggest that LY29

was effective in improving efficiency of ruminal utilization of feed CP by reducing excessive ruminal deamination of amino acids by obligate amino acid fermenting bacteria.

Key Words: rumen, bacteria, amino acid deamination

1190 Colonization Patterns of Forage Fragments by Rumen Microbes. C.A. Marsh*, W.C. Ellis, J.H. Matis, E. Moody, C. Lowe, and J. Johnson, *Texas A&M University, College Station, TX, Brazos.*

Level and rate of colonization of forage tissues by rumen microbes is postulated as causal of enhanced digestion rate of potentially digestible NDF, and its rates of turnover and voluntary intake. The time course of association of diaminopimelic acid (DAPA) with residues of plant tissues *in situ* was studied to reflect patterns of immigration/growth rate and migration/lysis rate by the microbial ecosystem. It is recognized that DAPA concentrations vary among individual species of microbes, however, for present purposes it is assumed that the dynamics of DAPA is representative of dynamics of the microbial population. Leaf and stem parts of bahia grass (*Paspalum notatum Fuegge*) hay were separated and ground to pass a 2 mm sieve and then placed in the rumen in 40 micro porosity bags until removed after 0, 3, 6, 12, 18, 24, 36, 48, 60, 72, 96, 144 and 168 h residence time. Dried material from within the bag was hydrolyzed in sealed tubes in 6M hydrochloric acid and DAPA and amino acids determined via HPLC. Observed time courses of DAPA/g of initial DM appeared to involve three phases: 1) an initial rapid influx and efflux of DAPA, suggesting a rapid immigration/growth rate and subsequent rapid migration/lysis rate within the first 24 h, 2) a more gradual immigration/growth rate in excess of migration/lysis rate which reached an asymptotic level around d 5 and 3) a migration/lysis rate in excess of immigration/growth rate after d 5. The more gradual accumulation over d 2 through 5 conforms to a logistic model in which availability of substrate was not limiting the level of DAPA accumulation until after d 5. It is proposed that the patterns of DAPA observed reflect the dynamics of colonization of feed fragments by successive species of microbes having specific attachment preferences for different ecological niches associated with residues of the feed fragment. The rate and level of colonization must then be modeled as the sum of two phases: 1) the initial influx-efflux phase and 2) the subsequent logistic accumulation phase.

Key Words: Rumen, Microbes, Diaminopimelic acid

1191 Effect of pH and solid dilution rate on the amino acid profile of liquid and solid associated bacteria, and its impact on the estimation of the contribution of microbial amino acids to the total amino acid flow in a continuous culture system. M. Rodriguez, S. Calsamiglia, and A. Ferret, *Universidad Autonoma de Barcelona, Spain.*

Eight dual-flow continuous culture fermenters (1320 mL) were used in two consecutive periods to study the effects of pH and solid dilution rates on the estimation of the contribution of microbial amino acids (AA) to the total amino acid flow. Fermenters were fed continuously a 60 to 40 forage to concentrate ratio (17% CP, 29.3% NDF, 20.4% ADF). Fermenters were maintained at a constant temperature (38°C) and liquid dilution rate (10% per h). Treatments were arranged in a factorial design, being pH (H = 6.4; L = 5.5) and solid dilution rate (S = 5, and F = 10 % per h) the main factors. Each period consisted in 7 days for adaptation and 3 days for sampling. The last day of the experiment, LAB and SAB pellets were isolated from each fermenter and their AA content (mg AA/g DM) analyzed. To estimate the contribution of microbial AA to the total AA flow using LAB or SAB, the AA content of each bacterial isolate was multiplied by the bacterial DM flow estimated within each isolate. Solid dilution rate and pH affected ($P < 0.05$) the AA profile of LAB and SAB. When the AA content was multiplied by the estimated bacterial DM flow within type of bacterial isolate, pH and dilution rate did not affect the estimated flow of AA. When the average across all treatments of the AA content (g/g DM) or flow (g/d) of SAB vs LAB were compared, no significant differences were detected, except for de content (g/g MS) of Tyr, His and Phe. Results demonstrate that the AA content of SAB and LAB may be different and affected by ruminal fermentation conditions. However, its implications on the estimation

of the contribution of microbial AA to the total supply may be quantitatively less important. Acknowledgment: Financial support provided by CICYT AGF97/0444.

Key Words: Bacteria amino acid profile, pH, Dilution rate

1192 Methane emissions from lactating dairy cows fed diets based on conserved forage and grain or pasture. T. R. Dhiman*, K. C. Olson, M. S. Zaman, I. S. MacQueen, and R. L. Boman, *Department of Animal, Dairy and Veterinary Sciences, Utah State University, Logan, UT 84322-4815.*

Methane (CH₄) emissions from cows are energetic losses and contribute to atmospheric greenhouse gases. Six lactating dairy cows (692 ± 58.9 kg BW, 3 intact and 3 rumen-cannulated) were used in a replicated 3 x 3 Latin Square experiment to study the influence of diet on methane emissions. Each period was 28 d. The first 21 d was for adaptation to diets and data were collected during the last 7 d in each period. Treatments were (1) a TMR containing grain and alfalfa hay in a 60:40 ratio, (2) 40% of daily requirements from grazing predominately perennial ryegrass and 60% from a grain mix, and (3) all nutrient intake from pasture grazing. Milk production and feed intake were recorded. Methane emissions from each cow were measured using sulfur hexafluoride as an external marker. Ruminal pH, NH₃-N, and VFA concentrations were measured in the rumen-cannulated cows. Daily DM intakes were 18.3, 13.3 and 15.9 kg d⁻¹ ($P = 0.07$) and 3.5% fat-corrected milk yields were 21.8, 20.4, and 18.3 kg d⁻¹ ($P = 0.76$) in treatments 1 through 3, respectively. Milk fat, protein, lactose, solids not fat, and urea contents did not respond to treatments. Methane emissions did not differ among treatments when expressed as g cow⁻¹d⁻¹ ($P = 0.96$), g kg⁻¹ of DM intake ($P = 0.46$), or g kg⁻¹ of fat-corrected milk ($P = 0.42$), with overall mean across treatments of 445.0 g cow⁻¹ d⁻¹, 29.2 g kg⁻¹ of DM intake ($P = 0.46$), and 29.1 g kg⁻¹ of fat-corrected milk. Acetic acid decreased and propionic acid increased ($P = 0.02$) under the pasture plus grain treatment relative to the other treatments. Ruminal pH, NH₃-N and other VFA concentrations did not differ among treatments. Dietary differences in this experiment had minimal influence on ruminal fermentation variables, or methane emissions in lactating dairy cows. The results from this study suggest that energetic loss in the form of methane from cows fed conserved forage and grain based diets was similar to those fed high quality pasture only.

Key Words: Cow, Milk, Methane

1193 A Role for Rumen Microbial Protein Synthesis in Regulating Ruminal Turnover. W.C. Ellis*¹ and J. H. Matis¹, ¹Texas A & M University.

Ruminal turnover is commonly considered a physical process determined by passive, mixing and dilution of intake rate of undigested NDF, UF, by rumen load of UF. Ruminal flux of degraded dietary entities was investigated as possible regulating nutrients. Literature sources were used that reported varied expressions of turnover that were converted to a common expression of mean turnover rate through two rumen compartments, UF_{ke}. The UF_{ke} was computed from rare earth-compartmental model data. Where the turnover rate, k, was determined as the exponential dilution rate of intake rate of an indigestible marker/rumen load of indigestible marker, UF_{ke} was computed as 1/k. Mean rate of digestion of potentially digestible NDF, PDF (PDF_{kd}), was computed as the natural logarithm of NDF digested in the rumen/mean ruminal residence time of UF (1/UF_{ke}). Rumen degraded protein, RDP, ruminal degraded NDF, RDF, and rumen microbial protein efflux, MPE, were as reported. Ruminal flux of non-structural carbohydrates, RDNSC, was computed as OM - [(NDF+lipids+CP)0.8]. Ruminal flux of degraded carbohydrates, RDCHO, was computed as RDF+ RDNSC. Energetic efficiency of MPE was computed as MPE/RDCHO. The database consisted of 85 treatment means from 28 experiments. All variables were expressed as daily flux per kg BW and relationships were examined with MPE as the dependent variable and daily flux of ruminally degraded nutrients as the independent variables. A non-linear, convex relationship existed between rumen load of UF and UF_{ke}. This relationship possessed greater curvature than conformed to exponential expectations for a passive, mass action, turnover of UF. In experiments with cattle fed mixed diets, significant ($P < 0.05$) regression existed between rumen load of UF and intake rate or dietary concentrations of UF. Efficiency of rumen microbial protein efflux, MPE/RDCHO, was correlated ($P < 0.05$) with rates of ruminal degradation of RDP, PDF, and RDP/RDCHO. The same relationships lacked significance ($P > 0.05$) in the data for forage fed animals. These results imply that in cattle

fed mixed diets, ruminal turnover of UF was regulated metabolically in response to flux proportions of RDP/RDCHO that enhances efficiency of rumen microbial synthesis, MPE/RDCHO.

Key Words: Rumen, Microbial, Protein

1194 Effect of replacing dietary starch with sucrose on nutrient utilization by ruminal microorganisms during continuous culture fermentation. G. A. Varga¹, T. W. Cassidy¹, V. A. Ishler¹, X. Markantonatos^{*1}, N. D. Luchini², and G. A. Broderick³, ¹Pennsylvania State University, ²Bioproducts, Inc, ³U.S. Dairy Forage Research Center.

A dual flow continuous culture system was used to investigate the effects of replacing dietary starch with sucrose at various concentrations on nutrient digestibility and ruminal fermentation. Four diets were evaluated using a completely randomized design during four replicates. Diets were formulated to contain on a DM basis 40% alfalfa silage, 20% corn silage, 20.5% rolled high moisture shelled corn, 9% soybean meal, 2% fat, 1% vitamin-mineral supplement, 7.5% supplemental non-structural carbohydrate (NC) with a nutrient composition of 16.7% CP, 1.7 Mcal/kg NEL and 29% NDF. The NC fed in the four diets was: A) 7.5% starch, 0% sucrose; B) 5% starch, 2.5% sucrose; C) 2.5% starch, 5% sucrose; and D) 0% starch and 7.5% sucrose. Four continuous culture fermenters were used with solid mean retention time and liquid dilution rate of 24 h and 11%/h, respectively. On day 7-9 effluents were collected daily and composited for nutrient digestibility determination and for analysis of ammonia-N, and VFA. No differences were observed in pH throughout the day ranging from 5.67 to 6.21 with an overall mean of 5.97 ± 0.08. Ammonia-N concentration averaged 9.23 mg/100ml ± 0.66 with a trend (P<0.11) for a positive linear effect with increasing sucrose in the diet. Apparent DM digestibility was not different among treatments and averaged 46.8% ± 1.5. NDF digestibility increased linearly when sucrose was added to the diet and at the highest inclusion was 66.1% vs. 60.9% when compared to the all starch diet. Total VFA was not different among treatments and averaged 103.9 ± 0.66 mM. Branched chain VFA concentration decreased linearly with increasing sucrose in the diet. Bacterial N content was not affected by treatment. Replacing starch with sucrose in the diet resulted in an alteration in microbial fermentation such that NDF digestibility was enhanced.

Key Words: Sugar, Starch, Ruminal fermentation

1195 In vitro effects of lactate-utilizing rumen bacteria on ruminal fermentation. S.-W. Kim*, S. R. Rust, H. Roman-Rosario, and M. T. Yokoyama, Michigan State University, East Lansing, MI.

A facultative lactate-utilizing bacterium (Isolate 1) was isolated from the rumen of beef cattle fed a diet consisting of 95% corn silage and 5% of a protein-mineral supplement. The isolate was a gram positive rod with a Chinese character arrangement. It produced 36 mM of acetate, 58 mM of propionate and 37 mM of butyrate from 159 mM of lactate. When glucose was the carbon source, the bacterium produced only lactate. The bacterium was placed into a mixed rumen culture to evaluate its potential to alter VFA production. One mL of Isolate 1 was added to a round bottom flask that contained rumen fluid (50 mL) from hay-fed heifers, buffer (50 mL) and 3 g of readily fermentable substrates (starch, glucose, cellobiose, xylose, and casein). Triplicate flasks were incubated anaerobically at 39°C. Three mL of culture were removed at 0, 3, 6, 12, and 24 h of incubation while gassing flasks with O₂-free CO₂. The concentrations of lactate in cultures were 0.5, 4.1, 51.5, 117.7, and 128.0 mM for control and 10.8 (P < 0.05), 10.1, 45.4, 124.3, and 150.4 mM (P < 0.01) for Isolate 1 at 0, 3, 6, 12, and 24 h of incubation, respectively. VFA concentrations were not different among treatments through 24 h of incubation. Acidity was higher in Isolate 1 at 24 h (P < 0.01). The fermentation products after 24 h of incubation are shown in the Table below. The Isolate 1 did not affect VFA composition but increased the lactate concentration in mixed culture.

Item	Control	Isolate 1	SEM	P
Lactate (mM)	128.0	150.4	2.26	< 0.01
Total VFA (mM)	126.8	125.0	1.21	0.17
Acetate (mM)	66.6	65.6	0.42	0.49
Propionate (mM)	35.9	36.5	0.54	0.35
Butyrate (mM)	19.0	18.0	0.66	0.30
pH	4.33	4.19	0.02	< 0.01

Key Words: Lactate, Bacteria, Ruminal fermentation

1197 Ethanol absorption from the rumen. T. Veresegyhazy*¹, H. Febel², G. Nagy¹, and A. Rimanoczy¹, ¹Faculty of Veterinary Science, Szent Istvan University, Budapest, ²Research Institute of Animal Breeding and Nutrition, Herceghalom.

Ethanol absorption through the rumen was investigated in *in situ* experiments. Three British Milk ewes fitted with rumen cannula (Bar Diamond 8C) were used. The ruminal content was removed and the forestomachs were washed out with water. Subsequently the apparatus developed by Engelhardt and Sallmann (1972) for the isolation of rumen was put in place. After closing the cannula, 2.8 L of physiological saline solution, either 20 or 60 mL ethanol, 2 mL Cr-EDTA were infused respectively and the fluid volume was completed to 3 L with physiological saline solution. This was followed by removal of the 0-min sample intended for the determination of the initial ethanol and Cr-EDTA concentrations. Further samples were taken at 5, 15, 30, 45, 60 and 75 min. This process was repeated with each animal. Every data point represents the mean of 6 measurements. The Cr content was determined by atomic absorption. The concentration of ethanol was determined by gas chromatography. The fluid volume and ethanol content in the rumen were calculated according to the dilution rate of Cr-EDTA and the ethanol concentration in the samples. Absorbed ethanol was considered to be the difference of the ethanol content of the sample taken at 0 min and the other sampling time. During 75 min absorbed 81% of 20 mL and 64.2% of 60 mL ethanol. The amounts of absorbed ethanol were 16.2 and 38.5 mL respectively. The equations of absorption are $y = -0.0474x^2 + 5.6544x + 10.869$ and $y = -0.1377x^2 + 19.541x + 24.606$ using 20 and 60 mL ethanol respectively. Ethanol absorption is quicker when the ethanol concentration is higher. The speed of ethanol absorption decreased during experiments because of saliva production and ethanol elimination through the rumen wall. Drawing a graph the curves are characteristic to passive transport. Ethanol can penetrate through the rumen wall probably by passive transport mechanism.

Key Words: ethanol, absorption, rumen

1198 Influence of drinking saline water and feeding level on feed and water intake, digestibility, thermo-respiratory response and blood constituents in sheep. Mostafa Kobeisy*¹, Faisal Elhommosi¹, Galal Abdel-Hafiz¹, and Hassanain Badawy², ¹Animal Prod. Dept., Fac. of Agric., Assiut University, Assiut-Egypt., ²Desert Research Center, Cairo-Egypt.

The trial aimed to study the influence of drinking saline water along with different nutritional conditions on digestive function, thermo-respiratory response and blood constituents in Saidi sheep. Six clinically healthy Saidi rams over one year old with an average body weight of 40 kg were used in this study. Saline water was fresh tap water containing 1.5% of commercial sodium chloride. Feed and water intake were recorded daily and blood samples were taken for Hb and PCV %, and serum total protein, albumin, globulin, triglycerides, cholesterol, AST and ALT determination. Drinking saline water decreased feed intake by about 15% and increased (P<0.01) water intake by about 42%. Digestibility coefficients of ether extract and acid detergent fiber were lower (P<0.05) in animals drinking saline water than those drinking tap water. Drinking saline water decreased (P<0.05) respiration rate, whereas rectal temperature was not significantly affected. Animals drinking saline water had higher (P<0.01) PCV %, and serum albumin and triglycerides concentrations than those drinking tap water. Under drinking saline water conditions, animals fed ad libitum level had significantly higher concentrations of Hb, PCV and serum albumin than those fed restricted level.

Key Words: Sheep, saline water, digestibility, blood, thermo-respiratory response

1199 Influence of supplemental chromium on performance, concentrations of liver triglycerides, and blood metabolites during the transition period of dairy cows. J. A. Jackson*, V. Akay, R. Scaletti, S. T. Franklin, D. M. Amaral-Phillips, C. H. Hamilton, and R. J. Harmon, *University of Kentucky, Lexington, Kentucky.*

This study evaluated the effects of dietary Cr supplementation on DMI, milk yield, liver triglycerides and blood metabolites in lactating dairy cows from wk 4 prepartum until 8 wk postpartum. Twenty-four Holstein cows (10 primiparous) were blocked by expected calving date and parity and randomly assigned to either the basal diet (control) or control diet supplemented with 11.5 or 8.0 mg / head / d of Cr, as chromium picolinate, for multiparous and primiparous cows, respectively. Cows were housed in tie stalls for approximately 40 days before the expected calving date and fed a close-up dry cow TMR until calving. At calving, they were fed a lactation TMR with DM containing 30 % corn silage, 30 % alfalfa silage and a 20 % crude protein concentrate mix. Blood samples were collected on d 30 and 15 before expected calving date and on d 3, 30 and 60 after calving and analyzed for plasma NEFA and BHBA, and serum triglyceride, insulin and cortisol. Liver samples were obtained on d 30 and 15 before calving and on d 3 and 30 after calving and analyzed for triglycerides. No differences were detected in DMI between treatments. Least squares means for wk 5 to 8 were 22.0 versus 21.8 kg/d for the control and Cr supplemented groups. No differences ($P > 0.05$) were detected in milk yield between treatments and averaged 36.8 and 34.6 kg/d for control and Cr supplemented groups, respectively. The percentage of fat was higher ($P < 0.05$) and protein trended higher ($P = 0.13$) in the milk of cows fed the Cr supplemented diet. Liver triglycerides averaged 3.9 and 3.3 % wet weight (NS) on d 3 after calving for the control and Cr supplemented groups, respectively. Chromium supplementation did not significantly alter plasma NEFA and BHBA, or serum triglyceride, insulin or cortisol concentrations at any sampling date or when averaged over the sampling dates. However, BHBA trended lower ($P = 0.10$) for the Cr supplemented versus the control cows on d 3 after calving. Results suggest that Cr supplementation during the transition period had no effect on DMI or milk yield. Blood metabolites and liver lipids were largely unaffected by Cr supplementation.

Key Words: Transition dairy cow, Dietary chromium supplementation, Fatty liver disease

1200 Effect of dietary phosphorus concentration on estrous behavior of lactating dairy cows. H. Lopez*¹, Z. Wu¹, R. Chere², L. D. Satter^{1,2}, and M. C. Wiltbank¹, ¹*Dairy Science Department, University of Wisconsin, Madison*, ²*US Dairy Forage Research Center, USDA-ARS, Madison.*

It is common for dairy producers to increase dietary phosphorus (P) above NRC requirements in an attempt to increase expression of estrus. The objective of this study was to determine the effect of dietary P concentrations of .38 or .48% of the TMR (DM basis) on estrous behavior of lactating cows as measured by a radiotelemetric system (HeatWatch[®] DDX, Denver, CO). At calving 48 Holstein cows were randomly assigned to one of the dietary treatments. Cows were housed in a free-stall barn and received a radiotelemetric transmitter on d 45 postpartum to record estrous standing activity. Observations on estrous behavior presented here are from the first year of a two-year study published elsewhere (J. Dairy Sci. 83:1052). The radiotelemetric system was employed only during the first year of that study. The total number of estrous periods recorded for the 48 cows was 83. The mean duration of estrous cycles was 22±0.8 d with a range of 17 to 26 d and 21±0.6 d with a range of 16 to 29 d for cows fed the .38 and .48% P diets, respectively ($P = 0.82$). The mean duration of estrus was 9.1±1.0 and 8.8±1.1 h for cows fed the .38 and .48% P diets, respectively ($P = 0.82$). The average number of mounts during estrus was 7.5±1.2 and 8.0±1.5 ($P = 0.81$) and the total mounting time was 29.6±1.0 and 31.9±5.8 s ($P = 0.75$) for cows fed the .38 and .48% P diets, respectively. Phosphorus treatment had no detectable effect ($P = 0.87$) on intensity and duration of estrous behavior.

Intensity and duration of estrus ¹	.38% P (n=42)		.48% P (n=41)	
	n	%	n	%
Low intensity, short duration	10	24	13	32
Low intensity, long duration	19	45	17	41
High intensity, short duration	11	26	9	22
High intensity, long duration	2	5	2	5

¹Estrus was characterized by standing events as low (<1.5/h) or high (≥1.5/h) intensity and by estrus duration as short (<7 h) or long (≥7h).

Key Words: Dairy Cows, Estrous Behavior, Phosphorus Requirement

1201 Mineral content of Acacia mangium Willd under defoliation conditions. T. Clavero*, E. Miquelena, and A. Rodriguez-Petit, ¹*La Universidad del Zulia.*

A field experiment under tropical dry forest condition was carried out in Zulia, Venezuela with the objective of determining the effect of cutting frequency and height of clipping on mineral content of leaves on Acacia mangium Willd. The factors studied were three frequencies (6, 9 and 12 weeks) and three defoliation heights (50, 75 and 100 cm) A split-plot in a random block design with three replications was used. The results showed highly significant differences ($P < 0.05$) for frequency and height interaction on the concentration of K, Mn and Zn. Calcium, Mg, Na and P were only affected by maturity. The principal effect on mineral content of leaves in Acacia mangium was age. Mineral concentration decreases due to translocation from leaves to branches and stems with increasing maturity.

Key Words: Acacia mangium, mineral composition, defoliation

1202 Pasture applied biosolids as related to copper status of grazing beef steers. M. E. Tiffany, L. R. McDowell*, G. A. O'Connor, F. G. Martin, N. S. Wilkinson, and H. Q. Nguyen, *University of Florida.*

Angus yearling steers (N=96) were randomly assigned to bahiagrass pastures (N=32) treated with 3 high Mo-containing biosolids varying in mineral content for 151 d and evaluated for mineral status, with special attention to Cu. The biosolids are classified as high quality and originated from Tampa (T) and Largo (L), FL and Baltimore (B), MD. Copper concentrations of biosolids varied from 431-989 ppm and Mo from 12-60 ppm. Biosolids and NH₄NO₃ (control) fertilizer was applied to 0.81-ha pastures at a rate of either 179 kg N/ha (X) or 2, 3 and 6X: 1) control C, 1X; 2) L1X; 3) L2X; 4) B3X; 5) B6X; 6) T3X; and 7) T6X. The soils were acid (pH 5.0-5.8) and well drained (soil series of Millhopper sand). There were 3 animals per pasture with 4-6 replicates of treatments. One of 3 steers of each plot received a 3-ml subcutaneous injection of Cu glycinate (60 mg Cu/ml). Forage concentrations were low in Cu (<6 ppm) and Mo (<2 ppm) and high in S (>0.4%). At experiment termination, 1/3 of steers had slight-to-moderate hair discoloration. Cupric glycinate injections dramatically increased liver Cu, with an overall average of 185.9 ppm (dry basis) for injected steers compared to 96.6 ppm for noninjected cattle. Cu-injected animals had higher ($P < 0.001$) liver Cu than the two corresponding pen mates. At the end of the experiment, the means of all biosolids treatment animals that did not receive supplemental Cu had liver Cu considerably less than the control. Five of 6 biosolids treated steer groups had lower ($P < 0.001$) liver Cu (ppm) than the control C 1X (127) as follows: B3X (97), L1X (82), B6X (72), T6X (56) and T3X (49). In agreement with declining Cu status in livers, all plasma Cu treatment means resulting from biosolids applications were less than the critical concentration of 0.65 μg/ml. In agreement with low forage Mo concentrations, all liver samples were low in Mo. Liver Mo concentrations were well below the 5 mg/kg level considered toxic. Biosolids treated steers all had lower ($P < 0.05$) liver Zn than the controls, and steers on pastures B6X, T3X and T6X had lower liver Fe than controls. Implications: Pastures treated with high Mo-containing biosolids resulted in a decline of Cu status of steers. The decline in Cu status was not due to Mo, but most likely from low forage Cu (<6 ppm) and high forage S (>0.4%).

Key Words: Biosolids, Cattle, Fertilizer

1203 Effect of shade and organic zinc supplementation on performance of Brahman bull calves fed growing diets in dry tropic weather. R. Barajas* and A. Felix, *Universidad Autonoma de Sinaloa (Mexico).*

To determine the effect of shade and organic zinc supplementation on performance of Brahman bull calves feeding growing diets in dry tropic weather, 64 Brahman bull calves (BW = 294 kg) were used in a 28 day complete randomized block design experiment (September/2000). Shade (WS) or no shade (NS) in pens and diet supplemented or not with additional 30 ppm of zinc from Availa-Zn 100TM (Zinpro Corp.

MN). No shade pens were ground floors pens (6 x 16 m), provided with metallic feed bunker (2.8 m); in each of four NS pens, six bull calves were placed (16 m of of vital space and 0.46 m of feed bunk by head). Shaded pens were 6 x 26 m, ground floor and central shade (4.8 x 6.7 m; belted type; 3.5 m high; north-south oriented) supplied with metallic layer; ten bull calves were placed in each (15.6 m of vital space and 3.14 m of shade, and 0.6 m of feed bunk by head). Shade increased ($P < 0.03$) the final weight 2.3% (334 vs 342 kg) and ADG by 19% (1.42 vs 1.7 kg/d). The use of shade diminished ($P < 0.05$) DM intake 5% (10.08 vs 9.54 kg/d) and feed/gain by 20% (7.15 vs 5.71). The dietary intakes of net energy was 17% and 24% higher ($P < 0.02$) in the calves in WS treatment than in NS treatment. Extra zinc supplementation had no effect ($P > 0.10$) on performance of bull calves. An additive effect of shade plus zinc supplementation was observed ($P < 0.05$), improving final weight, ADG, feed/gain and NEM content of the diet. WS + Zn tended ($P < 0.06$) to increase NEg content of the diet, and had no effect ($P > 0.10$) on DM intake. It is concluded that the use of shade in pens improved the performance of Brahman bull calves in feedlots during the ending summer under dry tropic weather condition, and that organic zinc supplementation support and benefits for feedlot cattle only if environmental conditions are adequate.

Key Words: Beef cattle, Shade, Zinc

1204 Supplementation of ascorbic acid and plasma concentration in the neonatal dairy calf. T.R. Johnson^{*1}, S.D. Eicher², C.A. McKee¹, K.L. Cutshall³, M.L. Henry³, and S.P. Coburn³, ¹Purdue University, West Lafayette, IN, ²USDA-ARS, West Lafayette, IN, ³Indiana University Purdue University Fort Wayne, IN.

Forty-six female neonatal Holstein calves were fed colostrum and treated for 3 d as described in Purdue Dairy SOP C-1.0 Management of newborn calves. Calves were then switched to milk replacer (20% CP, 20%fat, all milk) fed in 2 equal feedings at 10% BW/d and adjusted weekly for the 6 wk study. Treatments were: 1. Control; 2. BG (a β -glucan product fed at 2.5% of dry milk replacer, NaturalChem. Industries, Ltd.); 3. Ascorbic acid (AA; Vitamin C 500 mg STAY-C 35, Roche Vitamin, Inc.); and 4. BG+AA, at the same concentrations as each supplement when fed alone. Milk replacer, water and supplements were mixed with a bakery wisk and fed in individual pails. Calves were fed replacer and supplements at 0600h and 1300h, and plasma was taken by jugular venipuncture into in heparinized vacutainers at 0830 h. Plasma was frozen at -80°C. Analysis of plasma AA concentration was conducted using a microspectrophotometer method (Bio. Chem. Med. 1973. 11:41-48). Data were analyzed by SAS PROC MIXED REML, with combined symmetry (CS) as covariate. Mean plasma AA were: Control, 2.15 \pm .34; BG, 2.24 \pm .34; AA, 2.46 \pm .36; BG+AA, 2.67 \pm .37 μ g/ml. Week effects approached significance ($P < .06$); and treatment and treatment x week effects were not different ($P > .65$). Although AA+BG effects were reflected in physiological, production and immunological variables (McKee et al. 2000. JDS 83: Suppl. 1. 134), the present plasma AA data supports other reports that suggest that plasma is not a good indicator of AA status.

Overall treatment means by week, (CS) covariate

	Wk 0	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6
Mean	2.52	2.30*	2.23*	2.16*	2.44	2.35	2.53
SE	0.22	0.22	0.22	0.22	0.22	0.22	0.22

* $P < 0.05$

Key Words: Ascorbic acid, β -glucan, Neonatal

1205 Effect of organic (Availa-Cu) versus inorganic (CuSO₄) Cu on the rate and extent of copper repletion in post-partum Brangus heifers. G. P. Yost¹, L. R. McDowell¹, C. K. Swenson³, and J. D. Arthington^{*2}, ¹University of Florida - IFAS, Dept. of Animal Sciences, Gainesville, ²Range Cattle Research and Education Center, Ona, ³Zinpro Corporation, Eden Prairie, MN.

It has been proposed that organic copper (Cu) is more bioavailable than inorganic sources of the element. In beef cattle research these benefits have been variable. We hypothesized that the bioavailability of organic Cu should be of specific importance to stressed cattle. The post-partum stress associated with first calf heifers is a result of increased calving difficulty, lactation, and continued growth of the heifer. Therefore, the objective of this study was to compare the effect of organic (Availa-Cu, Zinpro Corporation, Eden Prairie, MN) vs. inorganic (copper sulfate)

Cu supplementation in post-partum, lactating, first-calf heifers. Thirty-seven Cu-deficient, Brangus heifers were selected from a south-central Florida ranch. Two 14 d enrollment periods were utilized to account for calving dates over a 4-wk period. Within each period, and after calving, heifers were allocated to one of two treatments ($n = 12$ and 15 for organic and inorganic treatments, respectively). Copper treatments were formulated into a corn/cottonseed meal carrier at a targeted level of 15 ppm. Treatments were delivered for 83 d to individual pens housing 2 or 3 heifers. All heifers were provided ad-lib access to long stem limpgrass hay containing 8.7 ppm Cu. Heifers assigned to both treatments were initially Cu deficient (56 and 51 ppm liver Cu for organic and inorganic treatments, respectively). Liver Cu increased in all heifers regardless of treatment, however, heifers supplemented with organic Cu tended ($P = 0.17$) to have higher mean liver Cu values compared to those receiving inorganic Cu (139 vs. 109 ppm). Over 83 d of supplementation the rate of liver copper repletion was 2.21 vs. 1.73 mg/kg/d for organic and inorganic Cu, respectively. No treatment differences were detected in plasma ceruloplasmin concentrations. By d 83 post-partum, only 4 of 27 heifers had returned to estrus ($n = 2$ /treatment) as determined by P4 levels > 1 ng/mL for two consecutive 7 d samples. These data suggest that organic copper may provide post-partum, first calf heifers with a more bioavailable form of supplemental copper.

Key Words: Organic mineral, Copper, Heifer

1206 Supplementation effects of calcium salts of unsaturated fatty acids on ruminal environment and forage digestion in grazing dairy cows. S. Wagner¹, G.F. Schroeder^{*1-2}, G.A. Gagliostro³, I. Vidaurreta¹, and J. Couderc¹, ¹Fac.Cs. Agrarias UNMDP, ²CONICET, ³INTA EEA Balcarce, Argentina.

The objective was to determine if the supply of calcium salts of unsaturated fatty acids (UFA-Ca, 65% unsaturated FA) would affect ruminal environment and pasture NDF and CP digestion in dairy cows grazing an alfalfa pasture (DM=22.7%; NDF=25.7%; CP=25.0% and IVDMD=71.3%). Three Holstein cows fitted with ruminal cannulas were allotted to a 3 x 3 Latin Square. Treatments were as follows. In T0, cows received pasture plus 5 kg/d of ground corn and 0.4 kg/d of fish meal. In T1, 0.8 kg/d of UFA-Ca were added to the T0 diet and in T2 corn grain was isoenergetically replaced by 0.8 kg/d of UFA-Ca. Nylon bags containing fresh forage (5 g DM/bag) were incubated in the rumen and removed at 0, 3, 6, 9, 12, 16, 20, 24, 36, 48, and 72 h to estimate the in situ disappearance of NDF and CP. Ruminal pH values, concentrations of NH₃-N and total volatile fatty acid and parameters of in situ pasture NDF and CP disappearance were not affected by UFA-Ca supply. Results suggested that UFA-Ca behaved as inert fats when they were added to the diet of dairy cows grazing alfalfa pastures.

Item	Treatment			SEM	P <
	T0	T1	T2		
pH	5.8	5.9	5.8	0.05	0.20
NH3 (mg/dl)	17.9	18.3	16.8	4.95	0.81
VFA (mmol/L)	109.9	109.8	100.3	18.3	0.22
Acetate:Propionate	3.00	2.95	3.01	0.08	0.86
NDF degradation					
Soluble (%)	10.6	14.5	14.9	3.88	0.73
Degradable (%)	63.8	60.2	57.6	5.64	0.77
Rate of digestion (%/h)	6.63	6.60	7.70	0.72	0.57
Effective degradability 1	41.6	42.4	43.0	2.97	0.95
CP degradation					
Soluble (%)	52.4	56.8	60.2	2.56	0.30
Degradable (%)	44.6	40.2	36.1	2.45	0.25
Rate of digestion (%/h)	11.7	11.2	11.0	0.35	0.50
Effective degradability 1	80.4	80.9	81.6	1.29	0.81

1 Assuming a rate of passage of 7 %/h.

Key Words: Unsaturated fats, Ruminal digestion, Grazing condition

1207 Effects of Zinc and(or) monensin on the utilization of a barley-alfalfa diet in beef cattle. H. M. Arelovich*¹, H. E. Laborde¹, C. J. Ackerman², M. I. Amela¹, and M. B. Torreal¹, ¹Universidad Nacional Del Sur, Bahia Blanca, Argentina, ²Oregon State University, Corvallis, OR.

Previous research has indicated that the addition of 250 to 400 ppm Zn to low-quality forage diets altered rumen fermentation by retarding ammonia accumulation and increasing molar proportions of propionate. This experiment was designed to investigate the impacts of dietary inclusion of Zn and(or) monensin on the productive performance and blood metabolite changes in sixteen recently weaned Angus steer calves (198 kg initial liveweight). Steers were individually housed and fed a mixed diet of 50% cracked barley grain, 40% ground alfalfa hay and 10% sunflower meal at 0800 and 1700 daily in equal proportions. The composition of the diet was 14.3% CP, 46.1% NDF, 20.5% ADF and 6.7% ash. Four treatments were randomly allotted to four individually fed steers/treatment. Treatments were: 1) Control (C); 85% wheat middlings + 15% NaCl, 2) Zinc (Z); C + 450 ppm ZnCl₂; 3) monensin (M); C + 300 mg monensin and 4) zinc + monensin (ZM); C + 450 ppm Zn + 300 mg monensin. All treatments were added to the basal ration at a rate of 200 g/steer at 0800 and were fed for 77 d. Blood samples were collected via jugular venipuncture. Data was analyzed using non-orthogonal contrasts; 1) C vs all other treatments, 2) C vs Z, and 3) Z vs ZM. No differences ($P > .10$) were detected in any of the parameters measured. Therefore, we conclude that inclusion of zinc at the level of 450 ppm did not alter performance or blood parameters of steers fed a basal diet consisting of 50% cracked barley grain, 40% ground alfalfa hay and 10% sunflower meal. Dry matter intake, ADG, feed conversions (FC), total tract apparent OM digestibility (DIG), and results of blood analysis for hematocrite (HTC), glucose (GLU), urea (U), total protein (TP), alkaline phosphatase (ALKP) and creatinine (CRT), are reported in the following table.

	Blood Serum									
	ADG (g/d)	DMI (kg/d)	FC (g/g)	DIG (%)	HTC (%)	GLU (g/l)	U (g/l)	TP (g/dl)	ALKP (U/l)	CRT (mg/dl)
C	1013	7.7	.13	62	38	.91	.38	7.39	320	1.30
Z	1008	8.0	.13	63	39	.96	.40	7.24	292	1.27
M	1026	7.1	.15	67	37	.87	.39	7.24	358	1.35
ZM	982	7.4	.13	66	37	.89	.39	7.27	346	1.36
SE	52.5	.27	.01	.03	.9	.04	.02	.127	37.3	.045

^aStandard error of the means n = 16

Key Words: Zinc, Monensin, Beef

1208 Performance and conservation of phosphorus in growing cattle. L. W. Greene*^{1,2}, F. T. McCollum III¹, N. K. Chirase^{1,2}, and T. M. Montgomery², ¹Texas A&M University Agricultural Research and Extension Center, ²West Texas A&M University.

One hundred forty four crossbred heifers (average initial weight, 178 kg) were used in a 43 d receiving and 103 d growing trial. Cattle were randomly assigned to 12 pens and fed ad libitum a diet consisting of 50% steam flaked corn (SFC), 40% cottonseed hulls (CSH) and 10% protein/mineral/vitamin (PMV) supplement. Each pen was randomly assigned to either 1.4 kg brewers' grain yeast (BGY) top-dressed on the feed daily or no BGY. On d 44, growing diets were formulated using either SFC (39.7%), CSH (5.0%), soybean hulls (38.8%), fat (3.6%) and PVM-1 (13.0%) to contain 0.22% P or SFC (69.7%) CSH (18.0%), fat (1.8%) and PVM-2 (10.5%) to contain 0.33% P. The P diets were assigned to the 12 pens in a 2 X 2 factorial arrangement with BGY. During the growing period, diet intake was adjusted at 2 wk intervals to produce a projected ADG of 0.9 kg/d. On d 146, cattle were weighed and total pen manure weighed and sampled. Heifers fed BGY during the receiving period consumed 6.5% more feed ($P = .0001$; 6.7 vs 6.2 kg/d) and gained 23.4% more ($P = 0.02$; 0.94 vs 0.76 kg/d) than those fed the control diet. Heifers fed BGY were 15% more ($P = 0.01$) efficient than those fed the control diet (0.137 vs 0.119 gain/feed). No interaction occurred between BGY and dietary P during the growing period. Heifers fed BGY consumed more feed ($P = 0.03$; 5.58 vs 5.47 kg), had greater ADG ($P = 0.01$; 1.0 vs 0.93 kg/d) and improved feed conversion ($P = 0.04$; 0.178 vs 0.169 gain/feed) compared to those fed no BGY. BGY did not affect ($P = .50$) N and P retention on the pen surface. Feeding 0.22% P did not affect feed intake ($P = 0.98$), ADG ($P = 0.15$) or feed efficiency ($P = 0.12$) compared to heifers fed 0.33% P. However, feeding 0.22% P reduced the amount of P retained on the pen surface by 29% ($P = 0.03$).

Feeding BGY during the receiving and growing period increased heifer performance. Reducing dietary P in growing diets reduced the quantity of pen surface P without reducing performance.

Key Words: phosphorus, environment, yeast

1209 The effect of copper source and level on the rate and extent of copper repletion in Holstein heifers. G. P. Yost*¹, L. R. McDowell¹, C. K. Swenson³, and J. D. Arthington², ¹University of Florida – IFAS, Gainesville, ²University of Florida – IFAS, Ona, ³Zinpro Corporation, Eden Prairie, MN.

The objective of this study was to evaluate the rate and extent of Cu repletion in Holstein heifers using two Cu sources (organic and inorganic) at two levels (15 and 30 ppm). An additional repletion treatment included a Cu oxide bolus. Heifers (n=50) were individually fed a depletion diet fortified with Fe, S, and Mo at 50 ppm, 0.40%, and 15 ppm DM of the total diet, respectively. Following 70 d of depletion, heifers were stratified by liver Cu and randomly allotted to one of five repletion treatments. Four treatments consisted of feed sources of Cu (Feed-Cu), 1) CuSO₄ at 15 ppm, 2) CuSO₄ at 30 ppm, 3) Availa-Cu at 15 ppm, and 4) Availa-Cu at 30 ppm. A fifth treatment, consisting of an intraruminal bolus (Bolus), contained 12.5 g of Cu oxide needles. Repletion treatments were delivered in the same total mixed ration without supplemental Fe, S, and Mo. Copper status was assessed in blood and liver samples collected on 14 d intervals for 70 d. Irrespective of treatment, all heifers increased in body weight during the repletion period. Liver Cu increased in each Feed-Cu treatment over time. Bolus heifers reached a peak in liver Cu concentration (165.5 ppm) on d 28. Heifers receiving CuSO₄ at 30 ppm achieved higher liver Cu compared to heifers receiving CuSO₄ at 15 ppm, but not those receiving Availa-Cu at 15 or 30 ppm (88.2 and 137.3, and 98.1 and 118.5 ppm for CuSO₄ at 15 and 30 ppm and Availa-Cu at 15 and 30 ppm, respectively). Mean liver Cu for Bolus heifers (131.1 ppm) was greater ($P < 0.05$) than CuSO₄ at 15 ppm, but not other Feed-Cu treatments. Plasma ceruloplasmin was higher ($P < 0.001$) in Bolus heifers versus other treatments. No differences in plasma ceruloplasmin were detected for Feed-Cu source or level. Red blood cell superoxide dismutase activity was higher ($P < 0.05$) in Bolus heifers compared to heifers receiving Availa-Cu at 15 ppm, but not other Feed-Cu sources (1.03 and 0.79 units of activity for Bolus and Availa-Cu at 15 ppm, respectively). These results indicate that all Cu sources evaluated in this study elevated Cu status of depleted heifers, particularly when provided at higher dietary levels.

Key Words: Holstein, Repletion, Copper

1210 Effects of biotin on liver metabolism in lactating dairy cows. C. K. Reynolds*¹, A. J. Packington², and G. M. Weber³, ¹The University of Reading, UK, ²Roche Vitamins (UK), ³F. Hoffmann-La Roche Ltd., Switzerland.

The objective was to measure effects of supplemental biotin on portal-drained viscera (PDV) and liver (LIV) metabolism in 3 multiparous, catheterized, mid-lactation Holstein x Friesian cows (664 kg BW). A TMR of 30 % dried lucerne, 20 % grass silage, 50 % concentrates and 17.8 % CP (DM basis) was fed hourly at 97 % of ad libitum DMI. Added carrier (.5 kg ground wheat/d) without or with biotin (20 mg/d) was fed in a switch-back design with three 2-wk periods. Hourly measurements (8) of PDV and LIV blood flow and net nutrient flux (mmol/h) were obtained on d-14 of each period. Biotin had no effect ($P > .57$) on DMI (22.2 kg/d), milk yield (29.5 kg/d) or blood flow (L/h) for PDV (2020) or LIV (2570), but increased ($P < .02$) arterial hemoglobin (94.5 vs 98.7 g/L) and oxygen (5.35 vs 5.57 mM) concentration and decreased ($P < .07$) arterial CO₂ concentration (27.22 vs 26.94 mM). There was no effect ($P > .45$) of biotin on net flux of glucose, lactate, oxygen or b-OH-butyrate across PDV (19, 174, -3672 and 281, respectively) or LIV (686, -95, -3892 and 394, respectively). Similarly, biotin had no effect ($P > .28$) on net flux of acetate, propionate or n-butyrate across PDV (3390, 932 and 212, respectively) or LIV (1814, -858 and -152, respectively). Biotin did increase net PDV release of ammonia (703 vs 945; $P < .01$) and removal of urea (49 vs -218; $P < .07$). This was associated with a numerical increase in net PDV acetate release (3087 vs 3694) and suggests an effect on rumen fermentation and/or urease activity. Net LIV flux of ammonia (-882) and urea (824) were not affected ($P > .24$), but removal of i-valerate was increased (-39 vs -47; P

< .07), indicating an enhancement of LIV methylcrotonyl-CoA carboxylase activity. The decrease in blood CO₂ also suggests an enhancement of biotin dependent carboxylase activity. Biotin effects on carboxylase activity and hemoglobin may be of benefit to the dairy cow, especially in early lactation.

Key Words: Biotin, Liver, Lactation

1211 Organic chromium and selenium effects on performance, digestibility and carcass characteristics of lambs. I Dominguez-Vara^{*1}, S Gonzalez², C Garcia-Bojalil², R Barcena², M Cobos², G Mendoza², and L Landois², ¹Universidad Autonoma del Estado de Mexico, ²Colegio de Postgraduados.

Organic selenium (0.0, and 0.3 ppm as Sel-Plex-50) and chromium (0.0, 0.250 and 0.350 ppm as Biochromium; Alltech, Inc.) were fed for 95 d to 54 Rambouillet cross lambs (27.04.83 kg BW) in a complete random design experiment with a 2x3 factorial arrangement of treatments. An in vivo digestibility and nitrogen balance trial was done with 24 lambs (four/treatment). Lambs were slaughtered at the beginning (four) and at the end (30; 45.383.13 kg) to evaluate carcass variables by comparative slaughter and specific gravity. Means were analyzed by orthogonal contrasts (C): C1) 0 Se vs 0.3 ppm Se; C2) 0 Cr, 0 Se vs 0.250+0.350 ppm Cr, 0 Se; C3) 0 Cr, 0.3 ppm Se vs 0.250+0.350 ppm Cr, 0.3 ppm Se; C4) 0.250 ppm Cr, 0 Se vs 0.350 ppm Cr, 0 Se; 5) 0.250 ppm Cr, 0.3 ppm Se vs 0.350 ppm Cr, 0.3 ppm Se. Biochromium (0.0, 2.5 and 3.5 g/lamb/d) and Sel-Plex-50 (0.0 and 3.0 g/lamb/d) were fed individually every morning with the basal diet (% DM): sorghum grain 65.2, corn stover 12.8, DPW 12.0, alfalfa hay 2.0, vitamin and mineral premix 2.0, SBM 2.0, wheat bran 1.5, fish meal 1.5, urea 1.0. DMI was higher (P<0.08) for unsupplemented lambs (C2; 1265 vs 1186 g/d). Lambs receiving Cr and Se (C3) had better (P<0.05) feed conversion (6.4 vs 10.1), higher (P<0.01) ADG (229 vs 184 g/d), and heavier BW (48.7 vs 44.3 kg; P<0.001) and carcass (22.4 vs 20.9 kg; P<0.01). Cr (0.350 ppm) without Se (C4) improved feed conversion (5.92 vs 9.73; P<0.07), carcass weight (23.1 vs 20.7 kg; P<0.02); and yield (56.9 vs 53.4%; P<0.06). Lambs fed Cr with (C3) or without (C4) Se had higher digestibility of DM (70.3 vs 61.9%, P<0.0002, C3; 73.3 vs 62.6%, P<0.0001, C4) and CP (60.7 vs 48.9%, P<0.0002, C3; 65.1 vs 51.2%, P<0.0002, C4). Lambs receiving Cr and Se (C3) retained more (P<.0343) N (28.18 vs 11.74 g). Addition of organic Cr improved BW gain, carcass variables, feed conversion and digestibility, and N retention in lambs fed a 65% sorghum grain diet.

Key Words: Organic chromium, Organic selenium, digestibility

1212 Effects of source of supplemental zinc on heifer performance during receiving and finishing phases. G. A. Nunnery^{*1}, M. L. Galyean¹, and J. Horton², ¹Texas Tech University, Lubbock, TX, ²Kemin Industries, Des Moines, IA.

Ninety-seven beef heifers (British x Continental; average initial BW = 223.7 kg) were used to study the effects of Zn source on health and performance. On arrival at the Texas Tech University Burnett Center, heifers were weighed, tagged, vaccinated, treated with Micotil, dewormed, and assigned randomly to dirt-floor pens (three pens per treatment; eight heifers per pen). All heifers were fed a 65% concentrate diet that contained NRC (1996) recommended levels of vitamins and minerals, except Zn. Treatments were: control (no supplemental Zn) and 75 mg/kg of supplemental Zn from either zinc sulfate, zinc methionine, or zinc propionate (KemZin 2700TM; Kemin Ind., Des Moines, IA). During the 35-d receiving phase, heifers were monitored daily for signs of bovine respiratory disease, and suspect calves with rectal temperatures \geq 39.7° C were treated and returned to their pens. At the end of the receiving phase, all heifers were group-fed the control diet for 42 d, during which, the concentrate level of the diet was increased to the final 88% concentrate finishing diet. Heifers were then stratified by BW (within original treatments), assigned to feedlot pens (four heifers per pen; six pens per treatment), and implanted with Revalor H. Heifers were weighed at 28-d intervals throughout the finishing period. During the receiving phase, control heifers had a higher (P < .05) d-35 BW and were more efficient (P < .05) than heifers in the other three treatments. Dry matter intake and ADG did not differ (P > .05) among treatments for the 168-d finishing period; however, feed:gain was poorer (P < .05) for heifers in the control group than for the average of the other treatments. With the exception of KPH, which was less (P < .04) for ZnSO₄ than for the two organic Zn sources, carcass characteristics did not differ (P < .05).

In newly received cattle, neither level nor source of supplemental Zn affected heifer performance. Moreover, Zn source had minimal effects on performance and carcass characteristics of finishing heifers, but lack of supplemental Zn might negatively affect feed efficiency during the finishing phase.

Key Words: Zinc, Cattle, Feedlot

1213 Adaptations in amino acid concentrations, body fat and body protein in dairy cattle fed varying amounts of protein in the transition period. J. P. McNamara^{*}, J.J. Sage, T.L. Citron, and G.J. Phillips, Washington State University.

The objectives were: to determine effects of prepartum protein intake and dietary amino acid balance on production, amino acid concentrations, adaptations in body fat and protein and, indirectly, body protein breakdown in early lactation and to determine the effects of rates of milk production and feed intake on adaptations in body fat, protein and rate of protein breakdown. Holstein cows (42) were fed two concentrations of protein for 21 days prepartum (11 and 14 percent) with or without 20 g per d methionine hydroxy analog and then fed a common diet of 16 percent CP for 120 days postpartum. Subcutaneous fat biopsies were taken from 31 cows at 14 d before, 60, and 120 days after calving and the diameters of fat cells (FCD) were determined and body fat (BF) and protein (BP) were calculated using validated equations. Dry matter intake averaged 25.4 kg (SD 3.1 kg) and milk production 41.6 kg (SD 1.4 kg). Protein intake prepartum was positively related to DMI and milk production postpartum (P < 0.05); cows fed the 14 % CP ration ate 0.9 kg more DMI and gave 1.7 kg more milk than those fed the 11 % ration. Cows fed AT88 prepartum lost less (P < 0.05) body protein by d 60. From d 60 to d 120 BF increased 8.5 kg and 11.5 kg for low and high protein groups and BP increased 0.5 kg and 1.0 kg. Serum concentrations of branched chain amino acids fell (P < 0.05) 17 percent in the first 4 weeks postpartum, lysine fell 12 to 15 percent, histidine fell 16 percent, and methionine and cysteine increased 20 to 30 percent (all P < 0.05). The ratio of serum 3-methylhistidine to creatinine (3-MH:C) was determined to indicate muscle protein degradation. An increase in the 3-MH:C ratio in late gestation and very early lactation (P < 0.05) indicated increased BP breakdown, there was no effect of prepartum ration. This data set provides adequate information to challenge a mechanistic model of nutrient use in dairy cows during the early lactation period.

Key Words: lactation, metabolic model, body composition

1214 Challenging performance of a mechanistic model of metabolism to describe nutrient flux and body pools in early lactation. J. P. McNamara^{*}, J.J. Sage, T.L. Citron, and G.J. Phillips, Washington State University.

Data were collected to challenge the behavior and sensitivity of existing metabolic models (Molly, AAMolly, University of California, Davis) to describe changes in body fat, protein and amino acid concentrations in early lactation dairy cows. Holstein cows (42) were fed 11 or 14% CP diets with or without methionine analog (AT88) for 21 days prepartum and a common 16% CP diet from 1 to 120 DIM to determine effects on production, nutrient metabolism, and body composition. Rates of intake, milk composition and yield, serum metabolites, body fat and protein content were determined at intervals for the first 120 d of lactation. Postpartum dry matter intake averaged 25.4 kg/d (SEM = 0.7 kg/d) and the cows produced a mean of 40.7 kg/d milk (SEM = 1.2 kg/d). From 14 days precalving to 60 d postcalving, BP decreased (P < 0.05) 8.2 kg and 8.5 kg for the 11% and 14% CP treatments. From d 60 to 120, BP increased 0.6 kg. The ratio in serum of 3-MH:C was elevated at 7 d postpartum (P < 0.05) and the 3-MH:C ratio at d 7 was greater (P < 0.05) in cows fed 11% CP prepartum than in cows fed 14% CP. Higher-producing (> 45 kg milk/d) cows in this study mobilized (P < 0.05) up to 18 kg body protein in early lactation. Feed composition, DMI, initial body weight and composition observations were explicit model inputs. The model described milk production from feed intake only with as: simulated milk (kg/d) = 0.26 * observed + 28.9 kg /d with a regression coefficient of 0.61. When milk production potential was entered on an individual cow basis, the relation between observed and simulated milk production was: simulated = 0.903 * observed + 2.9 kg/d with a regression coefficient of 0.96. The model simulated BP change to 120 d similarly (within 1 SD) to observed (observed = 7.5, simulated = 10.5 kg) but a greater increase in body fat (124.8 kg

simulated vs - 41.7 kg observed). The model AAmolly describes use of sulfur amino acids, histidine and lysine and predicted utilization of these amino acids from body stores in early lactation, as was observed. These mechanistic models describe milk outputs from quite well, within 1 SD of observed. The description of changes in body fat and protein over a period of 1 to 3 weeks postpartum is still inadequate and will require better experimental data for improvement.

Key Words: lactation, metabolic model, body composition

1215 Effects of prepartum intake, postpartum induction of primary ketosis, and periparturient disorders on performance and blood metabolites in dairy cows. H. M. Dann*, J. K. Drackley, and D. E. Morin, *University of Illinois, Urbana.*

Multiparous Holstein cows were used to determine the effects of different prepartum intakes and postpartum health statuses on dry matter intake (DMI), milk yield, and blood metabolites. Cows were fed a diet (1.54 Mcal NE_L/kg, 14.1% CP) from dry-off to parturition at either ad libitum (A; n=17) or restricted (R; 80% of calculated NE_L requirements; n=18) intake. After parturition, all cows were fed a lactation diet (1.58 Mcal NE_L/kg, 16.8% CP). At 4 d in milk (DIM), cows were assigned to 3 groups: healthy-control (HC; n=6), healthy-ketosis induction (HK; n=9), and periparturient disorder (PD; n=17), based on a physical examination. HC and PD were fed for ad libitum intake. HK were fed at 50% of d 4 DMI from 5 DIM to signs of clinical ketosis or 14 DIM, and then returned to ad libitum intake. Prepartum DMI was higher and serum nonesterified fatty acids (NEFA) were lower for A than R (*P*<0.05). Serum glucose, Ca, and albumin did not differ between A and R at -14 DIM. Prepartum intake (A vs. R) did not affect DMI, milk yield, or blood metabolites postpartum. From 1-4 DIM, DMI was higher (*P*<0.05) for HC and HK than for PD. Milk yield was higher (*P*<0.05) for HC than PD; HK was intermediate. At 4 DIM, HC and HK had higher (*P*<0.05) Ca than PD. Albumin was higher (*P*<0.05) for HK than PD; HC was intermediate. Glucose and NEFA did not differ. From 5-14 DIM, DMI was higher (*P*<0.05) for HC than PD. HC produced more milk (*P*<0.05) than HK and PD. At 14 DIM or onset of clinical ketosis, glucose was higher (*P*<0.05) while NEFA and β-hydroxybutyrate (urine and plasma) were lower (*P*<0.05) for HC and PD than HK. Albumin was higher (*P*<0.05) for HC and HK than PD. Calcium was lower (*P*<0.05) for HK and PD than HC. From 15-42 DIM, DMI and milk yield did not differ. At 21 DIM, glucose, NEFA, Ca, and albumin did not differ. Prepartum intake did not affect postpartum performance or blood metabolites. Periparturient disorders and induction of ketosis negatively affected performance and blood metabolites.

Key Words: Ketosis, Transition Cow, Metabolism

1216 Rumen volume and liquid dilution rate in transition dairy cows. C. K. Reynolds*, D. J. Humphries, and J. D. Sutton, *The University of Reading, UK.*

The objective was to measure effects of transition and supplemental barley on rumen digesta fill and liquid dilution rate in 10 rumen cannulated Holstein x Friesian cows in late gestation and early lactation. Cows were fed a grass-silage based gestation TMR for BW (671 kg) stasis without (n = 5) or with (n = 5) 1 kg (as fed) barley/d for 6 wk before expected calving date (CD) and a maize-silage based lactation TMR beginning 7 d before expected CD (2 kg DM/d). After calving lactation TMR was fed for ad libitum DMI. Cows were fed equal meals at 8-h intervals. Rumen liquid volume, DM content and liquid dilution rate were estimated by marker dilution at an average of 17 and 8 d before and 10, 20 and 31 d after calving. Markers (CrEDTA or CoEDTA) were introduced into the rumen at separate times, either 1 h before or 1 h after feeding at 0830 h. Subsequent representative rumen samples were analyzed to determine marker dilution and DM concentration and results for each marker were averaged. Feeding barley had no effect (*P* > .10). Milk yield at d 10, 20 and 30 after calving was 36.5, 41.9 and 43.3 (SEM 1.5) kg/d, respectively. The data show that increases in DMI after calving are associated with increased rumen DM fill and liquid turnover, but total liquid content was not affected.

Day from CD...	-17	-8	10	20	31	SEM	P-Day
DMI, kg/d	10.8	9.8	16.5	20.2	18.8	.7	.01
Rumen DM, kg	7.1	7.0	8.3	9.5	10.3	.8	.01
Rumen liquid, kg	51.8	50.0	48.9	54.2	57.7	4.3	.26
Total digesta, kg	58.9	57.0	57.1	63.7	67.9	5.1	.15
Liquid dilution, %/h	14.8	15.1	17.7	17.5	16.2	.8	.02

Key Words: Rumen fill, Dairy cows, Transition

1217 Effects of dietary energy density on performance of transition dairy cows. E. Rabelo*, R. L. Rezende, S. J. Bertics, and R. R. Grummer, *University of Wisconsin, Madison.*

Forty cows and twenty heifers were used in a randomized block design to evaluate different dietary energy densities during the periparturient period. Prepartum (d -28 to calving) diets were dry-low (DL, 1.57 Mcal NEI/kg, 14% CP, 42% NDF, 34% NFC) and dry-high (DH, 1.66 Mcal NEI/kg, 14% CP, 34% NDF, 41% NFC). After calving, half of the cows from each prepartum treatment group were assigned to a low (L, 1.67 Mcal NEI/kg, 18% CP, 33% NDF, 37% NFC) or high (H, 1.74 Mcal NEI/kg, 18% CP, 27% NDF, 44% NFC) diet until d 20 postpartum. After d +20 postpartum, all cows were fed H until d +70. Prepartum DMI was higher for animals fed DH than DL (13.1 vs. 11.3 kg/d, *P* < .0001). Treatment differences for DMI during the prepartum tended to be more pronounced for cows compared to heifers (*P* < .13). There was a treatment by time interaction on DMI after calving; animals that were fed DH had higher DMI at the second wk of lactation compared to animals fed DL (*P* < .05). Animals fed H had a higher DMI for the first 20 d of lactation compared to animals fed L (16.3 vs. 15.0 kg/d, *P* < .06). Diets did not affect DMI after the third wk of lactation. Prepartum diets did not affect milk, fat or protein yield. Milk production increased faster for animals fed H compared to animals fed L (*P* < .001). There was a prepartum treatment x time interaction on milk fat content (*P* < .02). Animals fed DH had higher milk fat content during the second wk of lactation than animals fed DL (4.43 vs. 3.91%, *P* < .01); no differences were observed during subsequent weeks. Increasing dietary energy postpartum tended to decrease milk protein percentage (3.14 vs. 3.06%, *P* < .11) and did not affect milk fat percentage. Feeding diets with higher energy density prepartum positively affects DMI during the prepartum period and possibly during early lactation. Increasing energy density of the diet during the first 3 wk postpartum positively affects DMI and milk production during the first 3 wk of lactation.

Key Words: Transition cow, Dietary energy, Lactation

1218 Effects of dietary energy density on blood parameters and liver triglyceride of transition dairy cows. E. Rabelo*, R. L. Rezende, S. J. Bertics, and R. R. Grummer, *University of Wisconsin, Madison.*

Forty cows and twenty heifers were used in a randomized block design to evaluate dietary energy densities during the periparturient period. Prepartum (d -28 to calving) diets were dry-low (DL, 1.57 Mcal NEI/kg, 14% CP, 42% NDF, 34% NFC) and dry-high (DH, 1.66 Mcal NEI/kg, 14% CP, 34% NDF, 41% NFC). After calving, half of the cows from each prepartum treatment group were assigned to a low (L, 1.67 Mcal NEI/kg, 18% CP, 33% NDF, 37% NFC) or high (H, 1.74 Mcal NEI/kg, 18% CP, 27% NDF, 44% NFC) diet until d 20 postpartum. After d +20 postpartum, all cows were fed H until d +70. Blood samples were taken at d -7, +1, +4, +7, +21 and +35 relative to calving and analyzed for plasma BHBA, glucose, and NEFA, and serum insulin. Liver biopsies were taken on d +1, +21 and +35 relative to calving. Data through d +1 were statistically analyzed separately from data after d +1. Treatment differences for blood and liver parameters on specific days are indicated only when a treatment x day interaction was significant. There was a prepartum treatment effect on NEFA through d +1 (247 vs. 331 uEq/L, *P* < .01, DH vs. DL), with treatment differences being greatest at d +1 (500 vs. 733 uEq/L, *P* < .0001, DH vs. DL). Animals fed DH had lower NEFA at d +4 (483 vs. 511 uEq/L, *P* < .01) and BHBA at d +21 (5.8 vs. 8.2 mg/dl, *P* < 0.05), and higher glucose at d -7 and +7 (54.6 vs. 52.6 mg/dl, *P* < .10; 47.9 vs. 45.6 mg/dl, *P* < .10) and insulin at d -7 (17.8 vs. 13.7 uIU/ml, *P* < .01) than animals fed DL. At d +7 and +21, animals fed H had higher glucose (48.5 vs. 44.9, 49.6 vs. 44.6 mg/dl, *P* < .001) and insulin (12.3 vs. 9.9, 15.5 vs. 11.7 uIU/ml, *P* < .01), and

lower BHBA (4.8 vs.8.2, 4.5 vs. 9.6 mg/dl, $P < .001$) than animals fed L. Liver triglyceride at d +21 was lower for animals fed H compared to animals fed L (11.0 vs. 15.6 ug TG/ug DNA, $P < .06$). A more favorable metabolic profile occurs when increasing the energy density of the diet prepartum or immediately postpartum compared with delaying the increase until d +20 postpartum.

Key Words: Transition cow, Dietary energy, Blood and liver

1219 Changes in hepatic methylmalonylcoenzyme A mutase (MCM, E.C. 5.4.99.2) activity during the transition period in the dairy cows. B. Graulet^{*1}, A. Desrochers², and C.L. Girard¹, ¹Dairy and Swine R&D Centre, Agriculture and Agri-Food Canada, Lennoxville, ²Facult de Mdecine Vtrinaire, St-Hyacinthe, Canada.

The objective was to look at the activity of the hepatic cobalamin-dependent enzyme MCM in dairy cow during the transition period. This enzyme controls the utilisation of methylmalonyl-CoA for neoglucogenesis and thus might be strongly stimulated in dairy cow by the intake of transition and early lactation diets and the increased needs in glucose for milk production. Liver biopsies were taken up repeatedly from 6 multiparous cows 3 wk before calving (-3 wk) and at 2, 4 and 8 wk of lactation. MCM activity was assayed spectrophotometrically from purified mitochondrial matrix. MCM activity decreased from 14.04 ± 1.29 to $7.58 \pm .75$ nmol/min/mg of intramitochondrial proteins ($P < .037$) between -3 wk and 2 wk of lactation then returned ($P < .004$) and stayed at its initial level at wk 4 and 8. Apparent Km and Vmax values towards methylmalonyl-CoA (mean initial values : 175.2 ± 34.0 μ M and 19.96 ± 3.16 nmol/min/mg of protein, respectively) followed the same quadratic pattern ($P < .052$). The dose-response curves of MCM activity towards its cofactor adenosylcobalamin (AdoCbl) indicated the same variations around calving for the apomutase but not for the holomutase part of the activity which remained stable until wk 2 then increased from $4.95 \pm .45$ to $8.00 \pm .80$ nmol/min/mg of protein at wk 8 ($P < .023$). Holomutase activity represented 41.2, 65.3, 61.5 and 59.6 % of total MCM activity at -3, 2, 4 and 8 wk, respectively. This increase was associated to a reduction in plasma vitamin B12 concentrations (-33 %, $P < .003$). Apparent Vmax values towards AdoCbl (initial level $8.59 \pm .71$ nmol/min/mg of protein) varied also quadratically. Apparent Km values towards AdoCbl were constant until wk 2 ($.58 \pm .20$ to $.69 \pm .14$ μ M), decreased by 36 % at wk 4 ($P < .056$) and then returned to the

initial values at wk 8 ($P < .001$). Our results show that MCM activity is decreased during the first weeks of lactation and consequently might reduce neoglucogenesis.

Key Words: MethylmalonylCoA mutase, Cow, Lactation

1220 Effects of a modified stair-step compensatory growth model for gestating beef heifers. A. M. Encinias^{*}, H. B. Encinias, T. D. Klein, G. P. Lardy, M. L. Bauer, and C. S. Park, ¹North Dakota State University, Fargo, ND USA.

Thirty-six gestating Angus and Angus-cross heifers were used to evaluate the effects of energy restriction imposed at 90 d of gestation. Heifers were grouped by verified AI date into six pens (6 heifers/pen) and fed a grass hay/corn silage diet for 10 d. At 90 d of gestation, pens of heifers were assigned randomly to one of two dietary energy treatments: control (CON) or stair-step (SS). Control heifers were fed 20.4 Mcal ME/d from d 90 to 210 of gestation and 23.0 Mcal ME/d through d 270, to achieve 0.54 kg ADG (minus fetus). Stair-step heifers were fed 13.3 Mcal ME/d (65% of CON) from d 90 to 210 (restriction) of gestation and 29.9 Mcal ME/d (130% CON) through d 270 (refeeding). During restriction, diet was formulated to elicit no gain (minus fetus) in SS heifers. Three-day consecutive weights were used to measure initial and final period BW. Initial and final body condition was estimated for each period. Initial BW ($P = 0.72$; 463 (CON) vs 474 (SS) ± 21) and BCS ($P = 0.81$; 6.1 vs 6.1 ± 0.1) were not different between treatments. Imposed restriction, did not influence BW ($P = 0.20$; 540 vs 490 ± 26 kg) between CON and SS, respectively. However, by design, CON heifers had a greater BW change ($P = 0.004$; 77 vs 16 ± 8 kg) and ADG ($P = 0.004$; 0.64 vs 0.13 ± 0.06 kg) during the restriction period. As a result SS heifers decreased ($P = 0.001$) in BCS. During refeeding phase, compensatory response (2.77 kg ADG) was observed in SS through d 28. Energetic efficiency (kg ADG:Mcal ME) was also greater for SS during refeeding ($P = 0.002$; 0.054 vs 0.031). In addition, SS heifers achieved a higher ADG ($P = 0.001$; 1.61 vs 0.73 ± 0.05 kg) than CON during refeeding. At the conclusion of feeding phase, heifer BW ($P = 0.95$; 584 vs 587 ± 13 kg) and BCS ($P = 0.70$; 6.2 vs 6.1 ± 0.2) were similar among CON and SS, respectively. Compensatory response elicited by SS during refeeding, allowed heifers to reach a similar final BW and BCS compared to conventionally reared gestating beef heifers.

Key Words: Beef heifer, Stair-step compensatory growth, Gestation

PSA Processing and Products

1221 Influence of CO₂ cryogenic cooling on low populations of Salmonella Enteritidis in inoculated table eggs. J.B. Gurtler^{*} and D.E. Conner, Department of Poultry Science, Poultry Product Safety and Quality Program, Auburn University, AL .

Because Salmonella Enteritidis (SE) is the primary cause of foodborne illnesses arising from table eggs, there is interest in developing processes to limit SE risk. Cryogenic cooling with CO₂ improves microbial counts of naturally contaminated eggs and can reduce high SE populations in inoculated eggs. Furthermore, elevated CO₂ levels decrease SE growth in yolk-containing media. The present study was undertaken to determine the effects of CO₂ cryogenic cooling on SE propagation in eggs at low inoculum levels. Fresh eggs (with a mean temperature of 27C) were gathered and inoculated, via injection into albumen, to ca. 160 cfu/egg with SE. One half of the eggs were cooled at ca. -60C for 6 min with CO₂ in a prototype cryogenic cooling unit, producing a post-cooling egg temperature of 12.9C, and then stored at 7C. The remaining eggs were traditionally cooled, requiring 5 days to achieve 7C and held at that temperature thereafter. Egg pH and SE populations were determined every three days up to day 15 and then weekly up to day 49 of storage. Populations of SE remained static over the 49 days following cryogenic cooling, whereas SE populations increased significantly in traditionally cooled eggs. After day 6, cryogenically cooled eggs' SE populations were consistently 2.5-4.5 log₁₀ cfu/ml lower than those traditionally cooled. No marked difference was noticed in pH values. Rapid cooling with CO₂ effectively inhibited SE growth in stored table eggs, and therefore may provide an efficient controlled cooling process for maintaining and increasing safety of table eggs.

Key Words: Salmonella Enteritidis, eggs, CO₂

1222 Effect of soybean soapstock on laying hen performance and egg quality parameters. V. Pardo^{*1}, L. Landin¹, K. Waliszewski², M. Avalos¹, A. Flores¹, and L. Guzman¹, ¹Universidad Veracruzana, Veracruz, Veracruz/Mexico, ²Instituto Tecnológico de Veracruz, Veracruz, Veracruz/Mexico.

The aim of the study was to determine the effects of soybean soapstock in laying hen diets on performance and egg quality parameters since variations in feed can adversely affect egg parameters resulting in economic losses to poultry producers. A total of 192 White Leghorn laying hens, 20 wk of age, was housed in two double-deck cage batteries with 4 birds in each cage at 25C. The birds were allotted to six dietary treatments, with each treatment replicated four times randomly among the batteries with 8 birds for replicate. The diets were sorghum-meal ground based with soybean oil at 3.5% and were isocaloric and isonitrogenous. Feed and water were provided for *ad libitum* consumption. Diet T1 had 25%, diet T2 50%, diet T3 75% and diet T4 100% of soybean soapstock, which was added in the amount to reach the requirement of 1.5% linoleic acid and complemented with soybean oil, control diet with pigment (T5) and control diet without pigment (T6) had 100% soybean oil. Four eggs from each replicate were randomly selected daily during eight weeks, kept at 4C and analyzed within two days after collection for determination of egg quality parameters: egg weight, shell thickness, Haugh unit score, albumen and shape index. Production performance -number and weight of eggs produced, feed conversion and percentage of production per treatment were recorded. Data were analyzed by ANOVA ($P < 0.05$) and significant differences among treatment means were analyzed by Tukey and Dunnett tests using Minitab 10.5 statistical program. Results indicated that the egg quality parameters among treatments were not statistically different during the eight weeks. No statistical differences were observed in production performance during the first two

weeks but statistical difference was observed among T1, T2 and T3 diets with T4, T5 and T6 diets from the third to sixth week and no statistical difference was observed among T4, T5 and T6 diets. There were no statistical differences among treatments at the seven and eight weeks of production. Nevertheless, T4 production parameters were numerically higher than other treatments. Soybean soapstock can be recommended as a substitute of vegetable oil since no adverse effects on egg quality and production parameters were detected.

Key Words: Soybean soapstock, egg quality, production performance

1223 Development of generic HACCP model plans for the egg processing industry. Mindy Brashears¹, Shelly McKee-Hensarling¹, Jason Mann*¹, and Dennis Burson¹, ¹University of Nebraska.

To assist the egg processing industry with HACCP implementation and to help ensure the consuming public a safe egg product supply, a team of Extension Specialists with expertise in food safety, Hazard Analysis and Critical Control Points (HACCP) systems and egg processing developed 5 generic HACCP plans similar to those available for use at the USDA by meat and poultry processors. After examining various egg processes, 5 process categories were identified based on similarities among the various processes. The categories were as follows; not ready-to-eat shell eggs; spray dried egg products; pasteurized liquid egg products; ready-to-eat, heat treated egg products-boiled; and ready to eat specialty egg products. A flow diagram and product category description was developed for each category and verified by industry experts. The seven principles of HACCP as described by the National Advisory Committee for the Microbiological Criteria for Foods were followed to develop the HACCP plans. The majority of the hazards identified were microbial, primarily Salmonella. Metal could also be a significant hazard in some processes. For pasteurized liquid egg products, Critical Control Points (CCPs) were identified at the pasteurization step and the cooling steps. Pasteurization was also a CCP for the spray dried egg products. Ready to eat specialty egg products and boiled egg products had CCPs identified at the cooking and/or pasteurization steps, depending on the process. For the shell eggs, there were no kill steps in the process so storage temperatures and the anti-microbial wash steps were identified as being critical to ensure safety of the product. The generic plans also contain a list of references to support decisions made in the hazard analysis section of the plans. An overview of HACCP and how to use the generic plans are also included. The generic plans will be available to processors in hard copy format, electronic/CD ROM format and on-line for use by egg processors.

Key Words: egg processing, HACCP, Food Safety

1224 Tuna Oil as n-3 Fatty Acids Source to Egg Yolk. C. Castillo Badillo¹, M. Gonzalez Alcorta¹, E. Morales Barrera², S. Carrillo Dominguez*³, and R.M. Castillo Domnguez³, ¹Universidad Autonoma de Chapingo, Chapingo, Texcoco, Mexico, ²Instituto Nacional de Investigaciones Forestales, Agrcolas y Forestales, Chapingo, Texcoco, Mexico, ³Instituto Nacional de Ciencias Mdicas y Nutricion Salvador Zubirn, Mexico D.F., Mexico.

The inclusion of tuna oil in the laying hens diet can rebound in benefits for the human health because it enrich the egg with fatty acids omega 3, which diminishes the cardiovascular human disease incidence. The aim of this study was to evaluate the effect of substitution safflower oil by tuna oil in the laying hens ration, on egg lipids and fatty acids omega-6 and omega-3 content. The study was carried out with 160 Leghorn laying hens, 90 weeks old, allocated in four treatments (3:0, 2:1, 1:2, 0:3) with four replicates each one. The experimental data were collected during 56 days. It was carried out two egg sampling, at the 28 and at the 56 experimental days. It was randomly taken four eggs of each replicate. The eggs were freezing. AGn-6 and AGn-3 were analyzed by gas chromatography. It was not detected any significant difference ($P>0.05$) on the egg total lipids (TL) content at the first 28 experimental days. However, the AGn-3 egg content (mainly EPA and DHA) increased to 30 mg/g lipid in the treatment 2:1. To 56 days the TL content was reduced 7% in the same group and the egg fatty acids content was higher significantly ($P<0.05$), obtained until 32mg/g lipid AGn-3, mainly EPA and DHA. Those observations suggest that tuna oil dietary inclusion has a positive relationship with the fatty acids omega-3 egg enrichment.

Key Words: Tuna oil, n-3 Fatty acids, egg yolk

1225 Effect of cooking methods and packaging conditions on the TBARS and COPs of turkey thigh meat patties during storage. S. J. Hur*, M. Du, K. C. Nam, Y. H. Kim, and D. U. Ahn, Iowa state university.

Turkey thigh meats with skin were ground twice through a 3-mm plate and patties were prepared. Patties were cooked using 5 different methods (pan frying, oil deep frying, boiling, oven cooking, and microwaving) to an internal temperature of 85-90°C and packaged in either oxygen permeable PVC zipperbags or oxygen impermeable PVDC bags. The samples were analysed for TBARS and cholesterol oxidation products (COPs) after 0, 3, and 7 days of storage at 4°C. The TBARS of cooked meat increased during the storage regardless of cooking methods, but vacuum packaged thigh meat produced less TBARS and COPs than the aerobically packaged samples. At the beginning of storage, aerobically packaged meat cooked by boiling method produced higher TBARS than that of others. However, the TBARS of microwaved meat with vacuum packaging increased rapidly after 3 days of storage at 4°C. The amount of total COPs in cooked thigh meat increased with storage and the increase was linear with storage time. The level of total COPs in aerobically packaged cooked meat was higher than the vacuum-packaged meat. Microwaving produced higher level of total COPs in meat than other cooking methods during storage. The results indicated that the progress of cholesterol oxidation in cooked meat was similar to that of lipid oxidation, and the formation of lipid and cholesterol oxidation products in cooked meat was closely related to cooking temperature, cooking time, storage time, and packaging conditions.

Key Words: cooking methods, cholesterol oxidation products, TBARS

1226 Identification of Bacteria Found in Broiler Deboning Operations. Tam Mai* and Donald Conner, Auburn University.

Research was conducted to identify bacterial community members found in broiler deboning operations. The objectives of this study were to gain a general idea of identity of bacteria in chicken products and the processing environment, and to determine effects of processing on bacterial types. Samples were collected at random at the postchill-debone lines of the same commercial processing facility over three visits. Collection at each sampling time consisted of 20 whole carcass (C), 20 breast meat (B), 20 skin (S), and 20 equipment (E) samples. Each sample was cultured on tryptic soy agar, incubated at 37°C for 24 hours. Colonies with different morphology were picked and streaked for isolation. Using this procedure, a total of 600 bacterial isolates were obtained (201 C, 222 B, 80 S, 97 E). Each isolate was identified based on whole cell lipid composition. Among the 600 isolates, there were 35 different genera, representing 100 different species. *Staphylococcus* (21%), *Pseudomonas* (17%), *Flavobacterium* (16%), and *Acinetobacter* (13%) were the predominant genera. Bacterial community composition varied at the different sampling times; however, similar genera of bacteria were found consistently in breast meat and on processing equipment. Data indicate that predominant bacterial types in broiler meat change as products are processed.

Key Words: Bacteria, Identification, Processing

1227 Broiler skin and meat color changes during storage. M. Petracci*² and D. L. Fletcher¹, ¹University of Georgia, Athens, USA, ²University of Bologna, Bologna, ITALY.

It has been reported that both broiler skin color and meat color change during slaughter, processing, and storage. In recent years, systems have been developed for the express purpose of using computer based machine vision for evaluating carcass and meat quality. Many of these systems use color discrimination as a criteria. Therefore, a better understanding of the time scale and degree of color change is necessary to calibrate such systems and to predict ultimate product color. Four experiments were conducted to study the color changes during processing and storage of broiler carcass skin, and breast and leg meat. For skin color, broilers were subjected to either a semi-scald (50 C for 120 sec) or a sub-scald (57 C for 90 sec). Color was measured both on and off the pectoral feather tract. For breast and leg meat color, color was measured directly on the meat surface (without packaging) or on the packaged meat surface. CIELAB color values of lightness (L*), redness (a*), and yellowness (b*)

were measured every 20 min for the first 3 hours, every 30 minutes between 3 and 8 hours, hourly between 8 and 12 hours, and daily for 8 days. Results clearly show that both skin and meat color change dramatically during the first 6 hours postmortem, after which the change is less dramatic over the 8 days of storage. Semi-scalded birds changed more than sub-scalded birds, presumably due to the more stable color of the xanthophylls in the epidermis and less influence of changes in the underlying muscle tissue. These results show that computer assisted vision or color systems must account for these changes and should be factored into system calibration. Also, early color analyses for market products, although highly correlated with later product color, may not reflect final product color specifications.

Key Words: Broiler skin color, Broiler meat color, Color change during storage

1228 Use of marine algae to enrich DHA content of heavy broiler breast and thigh muscle. J.E. Garrett*¹, J.R. Abril¹, and M.D. Sims², ¹Omega Tech, Inc., Boulder, CO, ²Virginia Scientific Research, Harrisonburg, VA.

The production of meat enriched with omega-3 fatty acids has the potential to provide an alternative source to fatty fish for of these nutrients. Four hundred 44-day old broilers (200 male and 200 female) were sorted by sex randomly allotted to one of four treatments: Control (C); 17 g algae/bird/wk for 7 days followed by 3 g algae/bird/wk for 7 days (N); 10 g algae/bird/wk for 2 wks (E); and 34 g algae/bird/wk for 7 days followed by 6 g algae/bird/wk for 7 days (D). Marine algae used study was DHA Gold[®], Omega Tech, Inc., a rich source of decosahexaenoic acid (DHA). Diets were formulated to meet NRC requirements. Bird performance was not significantly ($P > .05$) affected by any treatment. At the end of the two-week feeding period, 30 males and 30 females were collected from each treatment and processed for carcass data. Twenty carcasses (10 male and 10 female)/trt were processed ready to cook and then ground for analysis, 20 carcasses (10 male and 10 female)/trt had breasts and thighs removed for analysis and 20 carcasses (10 male and 10 female)/trt were retained for sensory panel evaluation. Breast muscle had the following DHA concentration (mg/100 g of tissue) 9.6, 35.8, 50.7 and 69.7 for C, N, E and D, respectively. Thigh muscle had the following DHA concentration (mg/100 g of tissue) 12.2, 54.3, 76.4 and 109.2 for C, N, E and D. Each treatment resulted in a significant enrichment from other treatments. Sensory panel evaluation showed no difference in breast quality for 3 or 10 day cold storage, with the exception that breasts from D were identifiable but not objectionable. Thigh quality showed similar results with no difference in quality though D thighs were identifiable at 3 and 10 days of cold storage. Efficiency of enrichment of DHA averaged 20.6, 25.7 and 21.4% for N, E and D, respectively. Conclusions from this study indicate that feeding of marine algae is a viable method to provide an alternative source of DHA compared to traditional fish sources.

Key Words: Omega-3 fatty acids, Broiler, DHA, Breast muscle, Thigh muscle

1229 Growth of *Campylobacter jejuni* under Acidic Conditions. Lei Zhang* and Donald Conner, Auburn University.

Campylobacter jejuni is a prominent cause of human bacterial gastroenteritis, and there is a high prevalence of the organisms in raw poultry products. Acid resistance is an important factor affecting ability of enteric bacteria to colonize the GI tract, therefore, acid tolerance can affect efficiency of subsequent acidic treatments in eliminating enteric pathogens from processed carcasses. To test the effect of pH reduction on growth of *C. jejuni*, Brucella broth was acidified with citric, hydrochloric, or tartaric acid to pH 4.5-6.5 in 0.5 unit increments. Triplicate tubes with 10 ml acidified Brucella broth were inoculated with *C. jejuni* (10^4 CFU/ml) and incubated in an atmosphere of 10% CO₂, 5% O₂ and 85% N₂ at 42 °C. CCDA and Campy-Cefex plating media were used to enumerate *C. jejuni* at 0, 48, and 96 hours. The minimum test pH at which *C. jejuni* did not grow (inhibitory pH) was determined for each acid. In the pH range tested, the inhibitory pH was 4.5 for citric and hydrochloric acids, and pH 5.0 for tartaric acid. In the non-inhibitory pH range (pH 5.0-6.5 for citric and hydrochloric acids, pH 5.5-6.5 for tartaric acid), initial populations of viable cells increased to their highest numbers at 48 hours. Populations of viable cells were 2-3 LOG₁₀ CFU/ml higher at pH 6.5 than at the lowest pH value at which growth occurred (pH 5.0 for citric and hydrochloric acid, 5.5 for

tartaric acids). Results showed that *C. jejuni* has the ability to grow at moderately acidic environments; however, type of acidulant affects survival.

Key Words: *Campylobacter jejuni*, acidic conditions, growth

1230 Comparison of carcass damage in turkeys stunned on constant voltage and constant amperage electrical pre-slaughter stunning systems. J.D. Reiman* and J.A. Marcy, University of Arkansas.

Unacceptable carcass damage, primarily hemorrhage in the breast muscles, has been associated with electrical stunning systems. One factor that may induce hemorrhage is the fluctuation of current (amperage) applied to a single bird. This fluctuation is a function of the variation in resistance between birds and with the number of birds in the system in a constant voltage stunner. In four experiments, turkeys were stunned with either a constant voltage (DC, 480 Hz) or constant amperage (square wave AC, 480 Hz) electrical pre-slaughter stunning system, processed and evaluated for carcass damage. For each experiment, 60 commercially grown 4.5-6.5 kg female turkeys were randomly and individually subjected to one of four stun treatments (low constant voltage 13 V; high constant voltage 32 V; low constant amperage 10 mA; high constant amperage 25 mA). The physical reaction at the time of stun and during exsanguination was observed as the turkeys were processed through an automated slaughter system. The carcasses were chilled and held for 24 hours before cut-up and visual inspection. At 24 hours, each carcass was fabricated, the parts subjectively scored to describe the presence and severity of hemorrhagic damage, the pH of the breast muscle recorded (0.25, 1, 2, 24 h) and CIE L*a*b* values (24 h) measured. No difference ($P < 0.05$) in carcass damage was observed between any of the electrical stunning treatments. A lower pH ($P < 0.001$) occurred at 1 and 2 hours for both the low voltage and low amperage treatments. This may have resulted from a more rapid state of rigor development caused by greater physical activity at the time of stun, venisection and exsanguination as supported by higher stun reaction scores and observations. These results suggest little difference between constant voltage and constant current systems for preventing hemorrhaging in turkey carcasses along the parameters used in this study.

Key Words: Stunning, Turkey, Carcass damage

1231 Survival of *Campylobacter jejuni* on Poultry Skin and Meat at Varying Temperatures. M. A. Davis* and D. E. Conner, Auburn University, AL, USA.

Recent research showing a much higher prevalence of *Campylobacter* on skin-on poultry products vs skinless products suggests that contamination is associated primarily with poultry skin and that *Campylobacter* may not survive well on poultry meat. Therefore, survival of *Campylobacter* on poultry skin vs. meat was quantified. Pieces of skin and meat were irradiated to eliminate native microflora, and inoculated with *Campylobacter jejuni* ($>5.0 \times 10^5$ cfu/ml). Meat and skin samples were packaged in polystyrene trays, covered with Cryovac[®] film, then subjected to one of the following storage conditions: 1) 4C for 11 days, 2) 4C for one day, then -3C for 10 days, 3) 4C for one day, -3C for one day, then 4C for 9 days, or 4) 4C for one day, -3C for one day, 20C for one hour on day 2, then 4C for 9 days. On days 0, 2, 3, 5, 7, 9 and 11, populations of *Campylobacter* were determined. The experiment was replicated three times. In each experiment, populations of surviving *Campylobacter* were not affected by storage conditions ($p \geq 0.05$), and there was no interaction between temperature treatments and sample type. Surviving *Campylobacter* populations were affected ($p < 0.05$) by sample type (skin vs meat). *Campylobacter*, in the absence of competing microflora, survived well on both poultry skin and meat at the varying temperatures tested. In all experiments, higher populations were established on the inoculated skin vs inoculated meat. These populations remained consistently 0.4-0.9 log₁₀ cfu/g higher on skin vs meat. Poultry skin topography, which provides for rapid attachment and entrapment of *Campylobacter*, may account, in part, for these higher populations on skin.

Key Words: *Campylobacter*, Poultry, Skin

1232 Comparison of electrolyzed oxidizing water with various antimicrobial interventions to reduce *Salmonella* spp. on poultry. K. A. Barstad*, R. R. Sharma, A. Demirci, and C. N. Cutter, *Penn State University*.

Recently, electrolyzed oxidizing (EO) water has been demonstrated to significantly reduce foodborne pathogens associated with cutting boards, vegetables, and cell suspensions. EO water is generated by passing a dilute salt solution through an electrical field, resulting in a solution with a pH of approximately 2.6, a residual chlorine level of 10-60 mg/liter, and oxidation-reduction potential of about 1,150 mV. In this study, EO water, chlorine (CL), ozonated water (OZ), acetic acid (AA), and trisodium phosphate (TSP) were used to treat freshly slaughtered chicken carcasses experimentally inoculated with *Salmonella* Typhimurium ATCC 13311. Antimicrobials were applied to inoculated carcasses either by submersion (4C, 45 min) or spray washing (85 psi, 25C, 15 sec). Following treatments, remaining bacterial populations were determined and compared at day 0 and after 7 days of refrigerated storage. Immediately following submersion experiments, treatments with TSP and AA demonstrated a 1.41 log₁₀ reduction of *S. Typhimurium*, while EO water reduced the pathogen approximately 0.86 log₁₀. After 7 days of aerobic storage at 4C, EO water, OZ, TSP, and AA significantly reduced the pathogen, with detection of the pathogen only after selective enrichment. Remaining bacterial populations immediately following spray washing experiments were not statistically significant between treatments at day 0; TSP and EO water exhibited a 0.9 and 0.59 log₁₀ reduction of *S. Typhimurium*, respectively. After seven days of refrigerated storage, TSP, AA, and EO water affected a 2.17, 2.31, and 1.06 log₁₀ reduction, respectively. While TSP and AA are effective in reducing *S. Typhimurium* in these experiments, these compounds may be expensive for processors to use and can adversely affect the environment following disposal. The data from this study suggest that EO water, delivered to contaminated surfaces by submersion or spray washing, can effectively control pathogens on poultry surfaces, especially following extended refrigerated storage. In order to improve the immediate and long-term effect of EO water spray washing treatments against *S. Typhimurium* associated with poultry surfaces, further optimization studies are warranted.

Key Words: Electrolyzed oxidizing water, *Salmonella* spp., processing

1233 Application of Sodium Citrate or Sodium Lactate in Breast Meat Chicken Roll Processing. A. Supatanont¹ and T. C. Chen*¹, ¹*Mississippi State University*.

Studies were conducted to investigate and compare the effects of sodium citrate and sodium lactate on yields and quality characteristics of restructured breast meat chicken roll. Chicken breast meats were hand deboned from broiler carcasses, skinned, excess fat removed, and cut into approximately 2.5 cm cubes. The meat cubes were mixed with other ingredients and stuffed into casings to form 6 cm diameter chubs, which were cooked at 82.2C until the internal temperature reached 71.1C. After cooling, processing yields and quality characteristics of the chicken rolls were measured. Processing yield of chicken rolls were increased ($P < 0.05$) by the addition of either sodium citrate or sodium lactate. No differences ($P > 0.05$) in yield were observed among the 0.25%, 0.50%, and 0.75% of either of the additives. When compared to those of the non-treated controls, the Hunter color readings, WB shear values, and Hedonic sensory scores of chicken rolls were not affected ($P > 0.05$) by the addition of either sodium citrate or sodium lactate. The refrigerated shelf life of chicken rolls were effectively extended by the presence of sodium citrate or sodium lactate. The presence of 0.50% sodium citrate also retarded ($P < 0.05$) the rancidity development of chicken rolls, while little or no effects were observed for the sodium lactate. Data suggested that sodium citrate can serve as an alternate for the preservation of processed muscle foods.

Key Words: chicken roll, sodium citrate, sodium lactate

1234 Influence of measurement position on the color values of turkey breast meat. T. J. Buttles¹, J. Kalbfleisch¹, S. L. Noll¹, and B. S. Walters*², ¹*University of Minnesota, St. Paul, MN*, ²*University of Wisconsin - River Falls, River Falls, WI*.

Color has been identified as a quick, non-destructive method to screen poultry meat for abnormal muscle characteristics including pale, soft, and exudative (PSE). A uniform protocol for taking color measurements

has not been developed. One of the factors in developing a standard protocol is determining where to take the measurement. The objective of this study was to determine if different positions on the muscle give different color readings. CIE color readings for lightness (L^*) were taken on breast meat from 104, 20-wk-old turkey toms. The breast meat was deboned 24h postmortem and the color readings taken immediately after deboning. Ten different locations on the internal surface, 5 on each half of the breast, were analyzed. The mean L^* value was 49.75. Linear correlations between the 10 locations were determined by Pearson's correlation coefficients. The L^* values at the different positions were positively correlated, with values ranging from 0.12 to 0.71 with a mean value of 0.34. While many of these correlations were statistically significant, they did not show strong correlations. These results indicate that the position of the measurement may impact how the meat is categorized as normal versus light or dark. Further research is needed to confirm these results and to determine the best position for taking color measurements.

Key Words: Turkey, Meat color, Poultry

1235 Pinking in further-processed turkey due to residual nitrate reduction by *Pseudomonas fluorescens*. Chad Clem* and John Marcy, *University of Arkansas, Fayetteville, AR*.

Cooked poultry products occasionally develop a "pink" tint that is unappealing to consumers. A possible reason for this color development is the microbial reduction of residual nitrate in the processing water. This study investigated the role of *Pseudomonas fluorescens* in the nitrate reduction of processed turkey and the resulting pink discoloration found in the meat. Shaved turkey product, divided into 12 groups, was inoculated with 0, 50, or 200 ppm sodium nitrate (NaNO_3). Half of the treatments also received inoculums of *P. fluorescens*. After stuffing into impermeable casings and storing for either 12 or 60 h, the meat was cooked to 82 C and then evaluated for nitrite (NaNO_2) and color differences by colorimeter and sensory panel. The mean colorimeter value for redness from the samples treated with 200 ppm NaNO_3 and bacteria and stored for 60 h was 4.07, whereas that of the samples that were not treated with any NaNO_3 or bacteria and were held for only 12 h was 2.65. Sensory panels also rated samples treated with 200 ppm NaNO_3 significantly pinker than samples containing no added NaNO_3 . Storage time had a significant effect on the color of the turkey with 60 h treatments receiving significantly higher redness values than 12 h treatments. The samples with the highest NaNO_3 treatments that also received *P. fluorescens* inoculums produced the greatest NaNO_2 levels after cooking. These results indicate residual NaNO_3 , *P. fluorescens*, and extended storage time may all contribute to the unwanted pink color development that is sometimes seen in further-processed turkey meat.

Key Words: Pinking, Bacterial Nitrate Reduction, Processed Turkey Meat

1236 Effect of rosemary oleoresin on quality of ground thigh chicken meat packed in high oxygen modified atmosphere environment. T. Keokamnerd*, I. Y. Han, and P.L. Dawson, *Clemson University, Clemson, SC*.

This research was conducted to compare an antioxidant effect of four different rosemary oleoresin extracts and a control sample (no antioxidant added) on quality of ground chicken thigh packed in a high oxygen modified atmosphere (80% O_2 : 20% CO_2). All samples were stored in the "dark" at $0 \pm 3^\circ\text{C}$ from day 0 to day 3, after that the meat samples were transferred to a "lighted" refrigerator at $3 \pm 1^\circ\text{C}$ with a light intensity of approximately 850 lux. Color, total aerobic plate count, and TBARS of ground chicken meat were measured at days 0, 3, 6, 9 and 12. The sensory impact of rosemary oleoresin on odor and flavor of the samples was evaluated by a panel on day 1. Meat with added antioxidant had a slower rate of increase in TBARS compared to meat without added antioxidant. No difference in color change was observed due to the addition of antioxidant. Antioxidants used in this experiment did not show anti-microbial effect, however, rosemary oleoresin seemed to improve meat odor and flavor.

Key Words: Modified atmosphere, Ground chicken meat, Rosemary oleoresin

1237 Imaging system for fecal and ingesta detection on poultry carcasses. K. C. Lawrence, B. Park, W. R. Windham, and D. P. Smith*, *USDA, ARS.*

A hyperspectral imaging system was developed to detect surface contaminants on poultry carcasses. The system consists of a transportable stand, two quartz halogen line lights, a prism-grating-prism imaging spectrograph connected to a 1280x1024 pixel silicon CCD camera, and a computer with a frame-grabber card. The imaging system is capable of collecting spectral reflectance information from 430 to 900 nm with 1-nm resolution for every pixel of a carcass image. The resulting three-dimensional image cube is typically reduced to 320x340 pixels of spatial information with 512 pixels of spectral information for each spatial pixel. This paper reports the results of this system for the detection of ingesta from the crop or gizzard and feces from the duodenum, ceca, and colon on the surface of a poultry carcass. Sixteen six-week old male birds on a corn/soybean diet were meal-fed, subjected to an 8-hour feed withdrawal, cooped, slaughtered, hard scalded (57.5 C for 2 min.), picked, eviscerated, and feces and ingesta was collected. Uncontaminated carcasses were then immediately imaged. Next, feces and ingesta were applied to varying locations on the breast, wings, and legs of the carcass, typically three spots per contaminant, 12 spots per bird, for a total of 190 contaminant spots, and second images were taken. Results are presented for several data analysis techniques including principal component analysis, which includes all measured wavelengths, and the wavelength ratio of the 565-nm image divided by the 517-nm image. The wavelength-ratio images were further processed with background masking, thresholding, and histogram stretching. The threshold and histogram stretching values were fixed for all birds. Linear and square root histogram stretches were performed. Results indicated that 97.3 and 100 percent of the contaminants were detected with the linear and square-root histogram stretches, respectively. The research shows the feasibility of a real-time system for fecal and ingesta detection from two wavelength images at typical poultry processing line speeds.

Key Words: Feces, Imaging, Food safety

1238 Effects of post-mortem deboning time and L-value classification of raw fillets on color and texture characteristics of cooked broiler breast meat. B. G. Lyon*¹, E. T. Moran², C. E. Lyon¹, and E. M. Savage¹, ¹*USDA, ARS, Russell Research Center, Athens, GA*, ²*Auburn University, Auburn, AL.*

Color of raw broiler meat has consumer implications and may also be indicative of functional properties of the meat. In this study, broiler breast samples from two deboning times were sorted by instrumental color (Minolta); then evaluated for cooked color, aroma and texture. Samples were from 8 wk old male broilers (Ross X Hubbard HiY) subjected to common live production and normal pre-slaughter handling. After processing, *pectoralis majors* were removed from chilled carcasses either at 4-6 h (early, ED) or 24-30 h (late, LD) post-mortem. Fresh fillet light reflectance was measured 48 h after slaughter. Each fillet was

IQF, held at 0C, and sorted by L-value (lightness) into two groups, low (<46, LL) or high (>52, HL) from the total having a grand mean of 49. Thawed samples were cooked individually in heat-and-seal bags immersed in 85C water to internal temperature of 78C, and evaluated for aroma, shear force, and light reflectance measurements of outside surface, inside cut surfaces and decanted cook fluid. Thawed raw weight and cooked yield were not significantly different. Cooked L-values for outside and inside cut surface of EDHL were significantly higher than the other three groups. Significant differences in cooked liquid color measurements were found (EDLL < EDHL). Shear force values were significantly higher for EDHL breast meat. Aroma of EDLL was the least brothy, most chickeny and most bloody/serumy; EDHL samples were most metallic. These results agree with other reports that cooking reduces color variation. However, early deboning may present more color differences than late deboning. Further work is needed to elucidate factors that can allow prediction and control of breast meat color and quality.

Key Words: Broiler breast meat color, Instrumental L-values, Deboning time

1239 Lipid and Fatty Acid Composition of Some Specialty Eggs. Gita Cherian*, Troy B. Holsonbake, and Mary P. Goeger, *Oregon State University, Corvallis, Oregon, USA.*

Many specially fed and raised chicken eggs are available in the United States with labels such as 'vegetarian', 'cage-free', 'organic', 'non-medicated', 'naturally-nested' or 'free-range'. The objective of the present study was to compare the egg components, total fat and nutritionally important fatty acids in eggs with special labels or claims. A total of six different brands of eggs with labels such as 'vegetarian high n-3', 'free-range', 'organic', 'uncaged-non-medicated', 'vegetarian-cage-free' or 'cage-free-naturally-nested' were collected and analyzed. A significant (P <.05) difference was observed in the egg components and fatty acid content in different brands. The percent yolk was lower (P <.05) in 'organic' and 'cage-free-vegetarian eggs' with a concomitant increase (P <.05) in the percent white. The percent shell was lower (P <.05) in 'cage-free-vegetarian' and 'naturally-nested cage-free' eggs. No difference (P >.05) was observed in the total edible portion. The total lipids were lower (P <.05) in 'cage-free-vegetarian' eggs. However, this was not noticed in 'free-range', 'vegetarian' or 'naturally-nested-cage-free' eggs. The content of C16:0, C18:0 and total saturated fatty acids were lower (P <.05) in 'vegetarian high n-3' eggs. No difference was observed in the content of C16:1, C18:1 or total monounsaturated fatty acids. The content of n-3 fatty acids were lower (P <.05) in 'organic', 'vegetarian free-range' and 'cage-free' eggs. The ratio of total n-6:n-3 polyunsaturated fatty acids ranged from 39.2 for 'cage-free' to 11.5 for 'vegetarian high n-3' eggs (P <.05). No difference was observed in the total polyunsaturated fatty acid content of eggs (P >.05).

Key Words: Specialty Eggs, Lipids, Fatty Acids

PSA Immunology

1240 Enhanced macrophage function in broilers fed diets supplemented with *E. coli* bacterial cell powder. G. F. Erf*¹, T. K. Bersi¹, and Y. Toride², ¹*University of Arkansas, Fayetteville, AR, USA*, ²*Ajinomoto Co., Inc., Tokyo, Japan.*

Bacteria are important members of the gut flora and are known to play a role in innate immunity. Additionally, bacterial cell wall products such as lipopolysaccharide (LPS) and peptidoglycan are known to have immunopotentiating effects. In chickens, little information is available on immunopotentiating effects of orally administered bacterial cell wall products. This study was designed to examine and compare the effects of dietary administration of purified *E. coli* LPS and of *E. coli* bacterial cell powder (BCP) on macrophage function in broilers. Newly-hatched male broiler chicks were assigned to 8 treatment groups consisting of standard diet (control), standard diet supplemented with 1, 10, 100, or 1000 ppm *E. coli* BCP, or standard diet supplemented with 0.034, 0.34, or 3.4 ppm *E. coli* LPS. When the broilers were 3 to 4 weeks of age, Sephadex-elicited abdominal exudate cells (macrophages) were collected. Macrophages from at least 10 birds per diet were then cultured with or without *in vitro* LPS stimulation to assess oxidative radical production (oxidation of 2',7'-dichlorofluorescein diacetate), nitric oxide

production (nitrite assay), and tumoricidal activity (% killing of RP9 tumor cells). Dietary *E. coli* BCP administration did not affect oxidative radical production by macrophages, but did increase macrophage nitric oxide production and tumoricidal activity compared to controls. Similarly, addition of purified *E. coli* LPS to the diet had no effect on oxidative radical production. Macrophages from broilers fed 0.034 ppm *E. coli* LPS exhibited enhanced nitric oxide production and tumoricidal activity, however, these enhancing effects of dietary *E. coli* LPS were masked when macrophages were further stimulated with LPS in culture. Although both *E. coli* products enhanced macrophage function in young broilers, the immunopotentiating effects of *E. coli* BCP were more consistent than those of pure *E. coli* LPS.

Key Words: Broiler macrophage, Lipopolysaccharide, *E. coli* bacterial cell powder

1241 Enhanced macrophage function in broilers fed diets supplemented with digested bacterial cell powder prepared from *Brevibacterium lactofermentum*. T. K. Bersi*¹, B. B. Madison¹, M. K. Redhorse¹, Y. Toride², and G. F. Erf¹, ¹University of Arkansas, Fayetteville, AR, USA, ²Ajinomoto Co., Inc., Tokyo, Japan.

Bacterial cell wall products such as lipopolysaccharide (LPS) and peptidoglycan are known to have immunopotentiating effects. In chickens, little information is available on immunopotentiating effects of orally administered bacterial cell wall products. This study was designed to examine and compare the effects of dietary administration of purified muramyl dipeptide (MDP) and digested bacterial cell powder (DBCP) prepared from *B. lactofermentum* on macrophage function in broilers. Newly-hatched male broiler chicks were assigned to six treatment groups consisting of standard diet (control), standard diet supplemented with 10, 100, or 1000 ppm DBCP, or standard diet supplemented with 0.35 or 3.5 ppm purified MDP. When the broilers were 3 to 4 weeks of age, Sephadex-elicited abdominal exudate cells (macrophages) were collected from at least 10 birds per diet. Various aspects of macrophage function were examined *in vitro*, including adherence, phagocytosis of sheep red blood cells (SRBC), and phagocytosis of antibody-opsonized SRBC. Additionally, to assess oxidative radical production (oxidation of DCF-DA), nitric oxide production (nitrite assay), and tumoricidal activity (% killing of RP9 tumor cells), the cells were cultured with (stimulated macrophages) or without (unstimulated macrophages) LPS. Macrophages from broilers fed the DBCP diets exhibited enhanced phagocytosis of antibody-opsonized SRBC compared to controls. Additionally, dietary DBCP resulted in enhanced nitric oxide production and tumoricidal activity by unstimulated macrophages, and enhanced production of oxidative radicals and nitric oxide by stimulated macrophages. These enhancing effects of DBCP on macrophage function were observed when the diets contained 100 or 1000 ppm DBCP. Dietary administration of purified MDP did not significantly affect any of the parameters examined.

Key Words: Broiler macrophage, Muramyl dipeptide, Digested bacterial cell powder

1242 The Effects of Epigallocatechin Gallate on the Avian Macrophage *In Vitro*. Jennifer Paquette* and Fred McCorkle, PhD., Central Michigan University, Mt. Pleasant, MI.

Epigallocatechin gallate, EGCG, is the active polyphenol in green tea. EGCG has been shown to inhibit the growth of certain tumors through the inhibition of certain transcription factors. EGCG has also been shown to promote IL-1 production in monocytes and enhance the proliferation of B-cells. In this study, the effects of EGCG on several avian macrophage functions were examined. The macrophage is a major secretory cell within the immune system and aids in the phagocytosis and destruction of invading matter. The MQ-NCSU macrophage cell line was used. The null hypothesis was that EGCG would have no effect upon the avian macrophage function. Macrophage functions tested included the adherence and the phagocytosis. All data was performed in triplicate format and was analyzed using a one-way ANOVA. The cytotoxicity of EGCG to macrophages was performed at concentrations of 1×10^{-6} to 1×10^{-12} M. EGCG had no cytotoxic effects upon the avian macrophage. The remaining assays used concentration levels of 1×10^{-8} to 1×10^{-12} M. EGCG affected the ability of macrophages to adhere to a substrate at all doses tested (113.11 ± 16 at 1×10^{-12} M vs. 260 ± 24.9 for controls). The phagocytosis assay used sheep red blood cells (SRBC) and *Escherichia coli* (*E. coli*) as substrates. EGCG did not affect the ability of MQ-NCSU macrophages to phagocytize either substrate and did not affect the number of substrate particles taken into a macrophage ($24.00\% \pm 2.71$ at 1×10^{-8} M vs. $23.89\% \pm 2.31$ for controls). EGCG does affect the ability of MQ-NCSU macrophages to adhere but is not cytotoxic at the concentrations tested and does not affect phagocytosis of SRBC or *E. coli*.

Key Words: Epigallocatechin Gallate, Macrophage

1243 The *in vitro* effects of Caffeic Acid Phenethyl Ester, the active component of Bee Propolis, on the avian macrophage. Tricia Anscomb*¹ and McCorkle Fred¹, Central Michigan University, Mt. Pleasant, MI.

Interest in nutritional supplements has increased within the past decade. This includes increased interest in products from the common honeybee, *Apis* species. Dose ranges of caffeic acid phenethyl ester (CAPE), the active component of bee propolis, are unclear and few studies have determined the effects of CAPE on the immune system. The macrophage is one of the main cells of the immune system. This study determined the effects of CAPE on the avian macrophage line MQ-NCSU *in vitro*. MQ-NCSU is a well-established and studied macrophage line. The effects of CAPE on cytotoxicity, adherence, and phagocytosis were tested. Using the trypan blue exclusion test, CAPE was not cytotoxic to avian macrophages from 1×10^{-3} to 1×10^{-12} M. The average macrophage viability for controls and CAPE concentrations was 92%. CAPE did not have any effect on macrophage adherence (controls 128 ± 10 adhered cells versus 1×10^{-7} M CAPE 133 ± 8 adhered cells). The effect of CAPE on the ability of macrophages to phagocytize *Escherichia coli* was determined. The number of macrophages undergoing phagocytosis of *E. coli* was not statistically different (38 ± 2 macrophages). At 1×10^{-10} M CAPE statistically lowered the number of *E. coli* taken up per phagocytizing macrophage ($1.6 \pm .07$ *E. coli* versus $2.2 \pm .25$ *E. coli* for controls). All statistics were analyzed using a one-way ANOVA and performed in triplicate for reproducibility. This study suggests that CAPE is not toxic to the avian macrophage and does not inhibit macrophage adherence to substrate or phagocytosis of *E. coli*, at the concentrations tested. The results suggest that human consumption of bee products with CAPE does not harm macrophage functions.

Key Words: Caffeic Acid Phenethyl Ester, Macrophage, Immune system

1244 Pulmonary hypertensive response to endotoxin and immune activity in primed and unprimed broiler chickens. W. Wang*, R. F. Wideman, and G. F. Erf, University of Arkansas, Fayetteville, AR, USA.

Pilot studies in broiler chickens indicated that the magnitude of pulmonary hypertensive responses to intravenous endotoxin varied widely among individual birds, which might contribute to their variable susceptibilities to pulmonary hypertension syndrome (PHS, ascites). The purpose of this study was to determine whether immunologically primed broilers have more consistent and enhanced pulmonary hypertensive responses to intravenous endotoxin injections than controls. For this study, birds were primed using a particulate immunological stimulus known to result in an increase of lymphocyte aggregates in the lungs. The pulmonary and peripheral arterial pressures prior to and following intravenous administration of *Salmonella typhimurium* endotoxin were examined in primed and unprimed broilers when the birds were between four and five weeks of age. Additionally, the number of lymphocyte aggregates in the lungs, as well as, the proportions and concentrations of circulating white blood cells were assessed in primed and unprimed broilers. Results showed that the primed group resembled the control group in their pulmonary hypertensive responses to endotoxin in terms of time of onset, magnitude, duration, as well as the variability in response among individual birds. The respiratory rate was higher in primed than in control broilers. The concentration of white blood cells was similar in both groups, whereas the percentage of eosinophils in the blood was higher in primed broilers compared to controls ($P < 0.05$). Lung tissue weight decreased ($P = 0.056$) in the primed birds within 48 hours after priming. The right ventricle to total ventricle weight ratio was similar for the two groups. In conclusion, priming reduced lung weight and increased the density of pulmonary lymphocyte aggregates but did not affect the magnitude or consistency of the subsequent pulmonary hypertensive response to intravenous endotoxin challenge.

Key Words: Broiler leukocytes, Endotoxin, Pulmonary hypertension

1245 Humoral Immunity Against Newcastle Disease Virus in Broilers fed *S. cerevisiae* cell wall and aflatoxin. Elizabeth Santin*¹, A.C. Paulillo¹, E.L. Krabbe¹, A. Maiorka¹, and M. Macari¹, ¹FCAV - Universidade Estadual Paulista.

This study aimed to evaluate the effect of aflatoxin in the diet, in the presence or absence of cellular wall of *Saccharomyces cerevisiae* (CWSC) on the humoral immune response of broilers vaccinated and challenged

against Newcastle disease virus (NDV). The exposure of 320 broilers to 1 ppm of aflatoxin reduced their humoral immune response in broiler vaccinated against NDV ($P < 0.05$), and the CWSC ameliorated this parameter but did not significant ($P > 0.05$). All groups reacted to antigenic stimulation to NDV at 11 days of age, but the best hemoagglutination inhibiting (HI) antibodies titers was obtained in birds not exposed to aflatoxin (GMT 7.75, 7.50, 6.37 and 5.75 to the birds fed without aflatoxin and CWSC; birds fed CWSC; birds fed aflatoxin and CWSC and birds fed only aflatoxin, respectively). When these birds were challenged with the velogenic strains of VDN, all the birds exposed at aflatoxin died, but in the birds fed with aflatoxin plus CWSC it was observed 50% of protection against VDN, demonstrating the deleterious effects of this mycotoxin in the immune response of the broilers vaccinated against Newcastle disease, and although the CWSC did not show significant improvement in HI antibodies titers, the cell wall of *S. cerevisiae* ameliorated the immune response of the birds challenged with VDN. FAPESP:Proc. n. 99/12952-7

Key Words: Aflatoxin, Immunity, *S. cerevisiae*

1246 *In Vitro* or *In Vivo* Effects of Recombinant Turkey Interferon Gamma (rtIFN γ) on *Eimeria* Invasion or Infection. R Beltran^{*1}, P Augustine², M El Halawani³, H Danforth², A McElroy⁴, and D Caldwell¹, ¹Texas A&M University, College Station, TX, ²USDA/ARS/LPSI/PBEL, Beltsville, MD, ³University of Minnesota, St. Paul, MN, ⁴Virginia Tech, Blacksburg, VA.

IFN γ is integral to many parameters of cellular immunity and promotes the barrier nature of mucosal membranes to enteric pathogens in mammals. Our interest in gut immunity in commercial poultry led to our investigation of the *in vitro* and *in vivo* effects of rtIFN γ on pathophysiology and immunity to avian coccidia. *In vitro* experiments consisted of exposing baby hamster kidney cells (BHK) to increasing concentrations of rtIFN γ and measuring subsequent *E. tenella* (ET) sporozoite invasion in short-term culture. When BHK were pretreated with 0, 2.5, 25, 250, 500, or 1000 ng rtIFN γ per ml of cell culture medium 45 min prior to the addition of the sporozoites to confluent monolayers, ET invasion was significantly reduced ($P < .05$) in BHK exposed to concentrations of 25 ng rtIFN γ and higher. In a subsequent experiment, when BHK were pretreated with the same concentrations of rtIFN γ for 48 hours prior to sporozoite addition, significant differences in cellular invasion were not observed. *In vivo* investigation consisted of administering rtIFN γ to day-of-hatch turkey poults by intraperitoneal injection 30 min prior to *per os* challenge with *E. adenoeides* (EA) and measuring effects on cecal lesion development and body weight gain 6 days post EA challenge. When poults received rtIFN γ at concentrations of 0.25, 2.5, or 12.5 $\mu\text{g/poult}$, cecal lesions associated with EA challenge were significantly reduced ($P < .05$). Body weight gains of poults receiving rtIFN γ and EA were not statistically different from that of poults administered EA alone. Further, administration of rtIFN γ at 12.5 $\mu\text{g/poult}$ and EA resulted in body weight gains not statistically different from that of poults receiving only rtIFN γ . These data, while preliminary, suggest the potential involvement of IFN γ in the development of immunity to avian coccidia in commercial poultry.

Key Words: IFN γ , Coccidial Immunity

1248 Croos reactivity determination for *Salmonella enteritidis* biovar issatschenko and *Salmonella gallinarum* using LT antibodies in immunoblot technique. O. Urquiza^{*1}, G. Tellez¹, L. Paasch¹, G. Ruiz-Palacios², and B. Diaz², ¹Departamento de Produccion Animal Aves, FMVZ, UNAM, ²Departamento de Infectologia e Investigacion del instituto nacional de nutricion (INNSZ).

This study was carried out to determine by Immunoblot, cross reactivity among supernatant proteins (SP) and periplasmic proteins (PP) of *Salmonella enteritidis* biovar. Issatschenko against CT and LT antibodies and *Salmonella enteritidis* biovar. Issatschenko SP and PP antibodies produced in rabbit and *Salmonella gallinarum* total antibodies produced in chicken. Results obtained showed that *Salmonella enteritidis* biovar. Issatschenko after a 24 hours of growing is able to produce 1.7 mg/mL of SP and 0.303 mg/mL of PP. In 15% SDS- PAGE there were protein bands corresponding to 97, 66.2, 45 y less than 31 kDa with SP and with PP 66, 42, 35, 33, 32 y 24 kDa. The Immunoblot using Avidina \times Biotin and Peroxidasa conjugates, reveled homologous and cross reactivity more intensive with anti LT, anti SP and anti PP of

Salmonella enteritidis biovar. Issatschenko antibodies and anti Sg of *S. gallinarum* against *Salmonella enteritidis* biovar. Issatschenko SP and PP and PS and PP of the same *Salmonella* but produced a year ago. Any one of the antibodies used were able to detect reactivity against CT, except the homologous antibodies whose were positive controls. In the other hand, utilizing the anti Sg antibody against SP, PP and SP and PP of one year old of *Salmonella enteritidis* biovar. Issatschenko and PP of Sg FVA #1, a high number of protein bands were reveled and more bands were observed with fresh *Salmonella enteritidis* biovar. Issatschenko PP. The reactivity observed with anti LT against *Salmonella enteritidis* biovar. Issatschenko PP and *Salmonella gallinarum* PP could discriminate different protein bands by Immunoblot whom are visible by the use of total Sg antibodies. That discrimination could be used as a tool for differentiation among some salmonelas.

Key Words: *Salmonella issatschenko*, Exotoxins, Enterotoxic activity

1249 The Interleukin-1 β sequence of Japanese quail (*Coturnix coturnix japonica*) and Mallard ducks (*Anas platyrhynchos*). B.D. Humphrey^{*}, E.A. Koutsos, and K.C. Klasing, University of California, Davis, Davis, CA.

The Interleukin-1 β (IL-1 β) DNA sequence of Japanese quail and Mallard ducks was determined. This cytokine is produced in response to inflammatory agents such as gram-negative bacteria, and induces localized responses including tissue destruction and activation of lymphocytes and vascular endothelial cells. In addition, systemic effects of IL-1 β include induction of fever and the hepatic acute phase response. To stimulate production of IL-1 β , Japanese quail were injected with 7.5 mg lipopolysaccharide (LPS; isolated from *Salmonella typhimurium*)/kg body weight, and ducks were injected with 10⁶ fixed *E. coli* (wild type K12). Two hours after inoculation, spleen samples were taken from both quail and duck and analyzed for IL-1 β mRNA levels using RT-PCR procedure. PCR conditions for IL-1 β were based on previous work in our lab, and the PCR primer encompassed nucleotides 37 through 828 from the published chicken IL-1 β sequence (GenBank #Y15006). PCR products were isolated, purified, and the nucleotide sequence was determined. The quail and duck nucleotide sequences were analyzed for sequence homology using a protein-nucleotide database search program (BLAST). The isolated nucleotide sequence (735 nucleotides) from the spleen of Japanese quail was determined to be 93% homologous to chicken IL-1 β . The nucleotide sequence isolated from the spleen of Mallard ducks (637 nucleotides) was found to be 85% homologous to chicken IL-1 β . Isolation of the complete IL-1 β sequence is required to assess phylogenetic differences between chicken, quail and duck IL-1 β structure. However, it seems that the pro-inflammatory cytokine cascade functions in a similar manner in these avian species, as IL-1 β mRNA was induced and a systemic acute phase response occurred in Japanese quail and Mallard ducks as in chickens.

Key Words: IL-1 β , Japanese quail, Mallard duck

1250 Initiation of Humoral Immunity: The Role of Cytokines and Hormones in the Initiation of Humoral Immunity Using T-Independent and T-Dependent Antigens. A.E. Gehad¹, H.S. Lillehoj², G.L. Hendricks III³, and M.M. Mashaly^{*3}, ¹Virginia Commonwealth University, Richmond, VA/USA, ²USDA-ARS, Beltsville, MD/USA, ³The Pennsylvania State University, University Park, PA/USA.

The purpose of the present study was to investigate the role of different cytokines and hormones in the initiation of humoral immunity. Immature Cornell K-strain male chickens were injected i.v. with 8mg/kg BW of lipopolysaccharide (LPS) from *Escherichia coli*, a T-independent antigen or with 40mg/kg BW BSA, a T-dependent antigen. Control birds were injected with 0.9% saline. Blood and spleen were collected 0, 1, 3, 6, and 24 h following the injections. The blood was centrifuged and the plasma was collected. Plasma samples were assayed for Interleukin-1 (IL-1) like activity using the thymocyte co-mitogenesis assay following the precipitation of inhibitory factors with polyethylene glycol. Tumor necrosis factor- α (TNF- α) like activity was measured as cytotoxic activity against the L929 mouse fibroblast cell line. The plasma was also assayed for corticosterone and T₃ by RIA. Interleukin-2 (IL-2) activity was measured in the conditioned medium from splenic lymphocytes following their stimulation with the T-cell mitogen Concanavalin-A (Con-A) for 24 h. Interleukin-1 activity was increased significantly at 1, 3,

and 6 h post-LPS injection, whereas there was no change in IL-1 activity at any time postinjection in the BSA-injected birds. TNF- α activity significantly increased at 6 and 24 h post-LPS injection, whereas there was no difference in the TNF- α activity at any time postinjection in the BSA-injected birds. Interleukin-2 activity was decreased significantly at 3 h post-LPS injection compared to base line levels at 0 h. However, IL-2 activity increased at 3 h post-BSA injection compared to 3 h post saline injection. Corticosterone levels significantly increased 1, 3, and 6 h post-LPS injection, whereas there was no change in corticosterone levels at any time postinjection in the BSA-injected birds compared to saline injected birds. Tri-iodothyronine levels significantly decreased 3, 6, and 24 h post-LPS injection, whereas there was no change in T₃ levels at any time postinjection in the BSA-injected birds compared to saline injected birds. The results indicate that although LPS and BSA injection can induce a humoral antibody response in chickens, the mechanism of the initiation of this antibody response involving the activation of the cytokine network and the neuroendocrine system are different for each antigen.

Key Words: Chickens, Antigen, Cytokines and Hormones

1251 Control of coccidiosis in chicken by trickle immunisation. Srinivasan K¹, Dilipkumar Garikipati*², and Venkaram A², ¹Madras Vety College, ²College of Vety Sci, Tirupati.

Immunisation control of coccidiosis caused by *Eimeria tenella* was carried out by trickle immunisation (TI) method. Immunizing chickens daily with 100 number of oocysts at 1-7 days of age (experiment I), 1-14 days (experiment II), and 8-14 days (experiment III) of age. The corresponding doses were also administered at 1 and 8 days as double dose and at 8 days as single dose in experiment II and III, respectively. Chickens were challenged with 50,000 oocysts at 28 days of age and were sacrificed 7 days after injection. Highly significant increase in ceacal length was observed in experiment I and II, whereas no significant difference was noted in experiment II when compared to control. Trickle-immunized chickens showed lesser lesion score, decreased fecal oocyst output, and ceacal oocyst contents when compared to control. Further trickle immunized groups showed higher immunizing response than their corresponding single or double dosed groups against challenge infection. The results suggested that trickle immunization of chickens continuously

for 1-14 days of age conferred better protection than trickle immunization for 1-7 days or 8-14 days of age.

Key Words: coccidia, chicken, trickle immunisation

1252 gamma-Interferon and IL-2 activities in supernatant of lymphocytes on chicken splenocytes stimulated with concanavalin A. G. Gomez*¹, G. Tellez¹, A. Isibasi³, and V. Ortiz², ¹Departamento de Produccion Animal Aves, FMVZ, UNAM, ²Departamento de Biomedicina Molecular del CINVESTAV del IPN, ³Unidad de Investigacion Medica en Inmunoquimica del hosp. de especialidades del centro medico nacion.

Previous studies have shown a protection for the experimental challenge against infections resulting from *Salmonella gallinarum* and *Salmonella enteritidis* in chickens, through the manipulation of birds' immunocompetent system by the use of lymphokines (ILK) raw extract obtained from T lymphocytes of hyper-immunized birds with *Salmonella gallinarum* (ILK-Sg) or *Salmonella enteritidis* (ILK-Se), and re-stimulated with concanavalin A. In order to identify interleukines present in the ILK, the presence of interleukine-2 (IL-2) and Interferon was assessed. The results obtained show the presence of both interleukines in ILKSe. The chicken IL-2, as in other mammals, participates in the proliferation of T lymphocytes; however, a significant difference compared to other species is that there was a species barrier in its biological activity. The INF induced an increase in the expression of class I and class II molecules of the Major Histocompatibility Complex (MHC). The presence of INF in the supernatant, suggests that this interleukine could be participating in the protection effect which is conferred by the administration of ILK, encouraging macrophages and heterophils activation, which could be responsible for the bacteria elimination. Besides, these studies offer more evidences indicating that the observed immunity in the in vivo studies against *Salmonella gallinarum* and *Salmonella enteritidis* is probably induced by these important lymphokines. Studies are in progress to purify and identify the effector lymphokines genes in chickens, as well as a systemic research regarding the mechanism by means of which these lymphokines potentialized their protective effects.

Key Words: interleukines, interferon-gamma, interleukine-2

ADSA Dairy Foods: Microbiology and Cheese Technology

1253 Flavor development of cholesterol-reduced Cheddar cheese slurries. H. S. Kwak*¹, C. S. Chung¹, S. J. Lee¹, and J. Ahn¹, ¹Sejong University.

This study was carried out to find the development of flavor in cholesterol-reduced Cheddar cheese slurries by β -cyclodextrin (β -CD). The cheeses were made by 3 different treatments as followings: 1) control (no homogenization, no β -CD treatment), 2) Treatment A (1000psi homogenization, 10% -CD), and 3) Treatment B (cream separation, 10% β -CD). The cheese slurry was aged for 3 wk. The cholesterol removal was 79.30% (Treatment A) and 91.22% (Treatment B). Among 8 volatile flavor compounds, dimethylsulfide, 2-pentanone and 2-heptanone appeared to be insignificantly increased during 3 wk storage, and no difference was found among treatments as expected. The amounts of acetone and ethylacetate were slightly increased in control at 3 wk, however, no difference was found in others. Ethanol production was dramatically increase at 1 wk and decreased thereafter in all treatments. Most volatile flavor compounds were not significantly different among control and treatment A and B as expected. Based on our results, cheese slurry made by cheese milk after cream separation (36% milk fat) and 10% β -CD treatment showed a highest cholesterol removal. Therefore, this study provided a possibility of cholesterol-reduced Cheddar cheese manufacture without any flavor change.

Key Words: Low cholesterol Cheddar cheese, Flavor, Beta cyclodextrin

1254 Dynamic headspace analysis and sensory characteristics of ewes milk La Serena cheese. Mara Carbonell, Estrella Fernandez-Garcia*, and Manuel Nunez, Instituto Nacional de Investigacion y Tecnologia Agraria y Alimentaria (INIA).

La Serena cheese is a semi-soft variety, made in Extremadura (Spain) from raw milk of Merino ewes, coagulated with vegetable rennet. The objective of our study was to investigate the composition of the volatile

fraction of La Serena cheese, and its correlation with sensory characteristics. Duplicate batches of La Serena cheese were made at 4 dairies during the 4 seasonal periods. Cheese (60-day-old) samples were homogenized with sodium sulfate and an internal standard. An aliquot was extracted in a purge and trap apparatus. Volatiles were concentrated in a Tenax trap at 30C, and desorbed with He during 1 min at 230C directly into the injection port. Gas chromatography was carried out in a HP-6890 apparatus equipped with a HP Innowax capillary column and a HP 5973 mass spectrometer. Peaks were identified by comparison of retention times and ion spectra with those of real standards and of Wiley 275 library spectra. Quantitation was carried out by sum of characteristic ions abundance. Cheeses were scored by 14 trained panelists for quality and intensity of odor and aroma, on a 7-point scale. Volatile compounds found in the headspace of 60-day-old La Serena cheeses were 13 aldehydes, 8 ketones, 24 alcohols, 24 esters, 10 hydrocarbons, 14 terpenes, 3 sulfur compounds, 3 nitrogen compounds, 7 aromatic compounds and 5 free fatty acids. Most compounds were detected in cheeses made in all seasonal periods, and higher concentrations of most volatiles found in spring cheeses. Some terpenes were only detected in winter and spring cheeses. Analysis of variance showed significant seasonal differences of quality and intensity of cheese odor and aroma. Spring cheeses obtained the best quality scores, whereas winter cheeses had a more intense aroma. Odor intensity correlated positively with 2-butanone and 3-methyl-1-butanol, and negatively with terpenes, ethyl esters and quality of odor and aroma. A high concentration of 2-butanone was responsible for low quality scores, but high levels of esters resulted in improved quality scores even in the presence of high 2-butanone concentrations, as shown by Principal Component Analysis. Stepwise discriminant analysis of selected volatile compounds achieved

a correct classification of 100% cheeses in their respective seasonal periods.

Key Words: Volatile compounds, Sensory characteristics, La Serena cheese

1255 The volatile compounds of raw milk Manchego cheese and their relationship to some sensory attributes. Estrella Fernández-García* and Manuel Nunez, *Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA).*

Manchego cheese is the best known of Spanish ewes milk cheeses. The objective of this study was to isolate, identify and compare the relative amounts of volatile compounds in 6-month-old raw milk Manchego cheese made throughout the year. The correlation of certain volatile compounds with sensory characteristics is discussed. Cheese (15 g) was homogenized in an analytical blender with sodium sulfate (20 g) and an internal standard. The mixture (2 g) was subjected to helium purge at 50°C, 15 min, 10 min previous equilibration. Compounds were concentrated in a Tenax trap at 25°C. Desorption was at 230°C/0.5 min directly into the injection port at 220°C. Chromatography was carried out in a GC-MS system equipped with an HP Innovax capillary column. Main chemical families found in Manchego cheese were aldehydes, methylketones, alcohols and esters. Terpenes, sulfur and aromatic compounds, and hydrocarbons were also detected. Most aldehydes were at higher concentrations in spring cheeses. Major ketones were 2-propanone and 2-butanone. 2,3-Butanedione was more abundant in summer cheeses, possibly due to the higher level of starter inoculation in summer. Alcohols were quantitatively the main chemical family. Large quantities of ethanol, 2-propanol, 2-butanol and 3-methylbutanol were observed, but also of 2-pentanol and 2-heptanol. Branched chain alcohols were at higher concentrations in fall and winter, and at lower concentrations in summer cheeses. Twenty three species of esters were identified, with ethyl, propyl, branched chain alkyl and butyl esters as the most quantitatively important. Branched chain alkyl esters were less abundant in summer cheeses. Abundance of volatile compounds and sensory data were subjected to principal components analysis. Primary and secondary alcohols, 2-methylketones, and branched chain aldehydes and esters showed a high positive correlation with function 1, together with the descriptors rancid and piquant and aroma intensity. Aroma quality together with dimethyl disulfide showed a negative correlation coefficient with function 1. Branched chain alcohols, 2-butoxy-ethanol, butyl glycol acetate, dimethyl sulfide and isoamyl butyrate showed a high positive correlation with function 2, together with the aroma descriptor fruits-flowers.

Key Words: Volatiles, Sensory attributes, Manchego cheese

1256 Effect of long term frozen storage on Manchego-type cheese proteolysis. Esther Sendra*¹, Jose Pons¹, Jordi Saldo², Reyes Pla², Montserrat Mor-Mur², and Ventura Guamis², ¹Universidad Miguel Hernández, ²Universitat Autònoma de Barcelona.

Two batches of Manchego-type cheese were manufactured. After press, curds were distributed in 2 groups of 8 units each; control and treated (which were packaged in polyethylene bags, frozen at an ice front velocity of 1.5 cm/h). Control analysis were run in 1993: before salting (C₀) and after salting and 60 days of ripening (C₆₀). Treated groups were kept at -20° C during 7 years, defrosted at 0° C and sampled: just defrosted (day 0), after salting (days 1, 30 and 60 of ripening). Overall composition, nitrogen (nt) and nitrogen soluble fractions (ncn: at pH 4.6, nTCA: in 12% trichloroacetic acid) were determined (in duplicate) in all curds and cheese units and their relative indexes were calculated (nnc/nt, nTCA/nt). Moisture significantly decreased during frozen storage. Salt content dramatically increased. An increase in ncn/nt and nTCA/nt was observed in defrosted curds (P<.05). Therefore, rennet and bacterial induced proteolysis still go on at freezing conditions. Proteolysis was more intense in cheese obtained from frozen curds than in control.

	dry matter ¹		salt ¹		nitrogen ¹		ncn/nt		npn/nt	
	X̄	std	X̄	std	X̄	std	X̄	std	X̄	std
C ₀	47.87 ^a	.39	.29 ^a	.06	2.81 ^a	.03	6.35 ^a	.32	2.42 ^b	.23
0	52.29 ^b	1.13	.48 ^b	.07	3.37 ^b	.32	9.04 ^c	.14	5.18 ^a	.25
1	54.18 ^c	.96	2.62 ^c	.19	3.26 ^b	.10	7.35 ^b	.39	5.84 ^a	.26
30	61.36 ^d	.82	2.57 ^c	.19	3.67 ^c	.05	16.59 ^d	.68	17.82 ^d	.77
60	68.54 ^e	.63	3.22 ^d	.04	3.95 ^d	.05	20.99 ^e	.95	16.68 ^d	.68
C ₆₀	61.17 ^d	.31	2.10 ^c	.26	3.32 ^b	.10	21.40 ^e	.71	15.03 ^c	.50

¹ (% in wet basis); ^{a,b,c,d,e} values with the same letter within columns do not differ significantly (p<.05) by oneway ANOVA analysis.

Key Words: cheese, proteolysis, freezing

1257 Texture of artisan Spanish fresh goat's milk cheese. Esther Sendra*¹, Laura Alenda¹, Casilda Navarro¹, Estrella Sayas¹, Juana Fernández-Lpez¹, and Jos Angel Prez-Alvarez¹, ¹Universidad Miguel Hernández.

Servilleta is an artisan fresh goat's milk cheese that has not been typified or characterized. Distinctive characteristics are pasteurization conditions (82°C 10s), wrapping and pressing in cotton gausses with no use of molds and mild salting. Cheeses were sampled from 3 manufacturers, 3 times at monthly intervals (total: 9 samples per manufacturer). Overall composition (triplicate), stress relaxation test (4 replicates) and 80% uniaxial compression test (6 replicates) were run. Oneway ANOVA analysis was run (P<.05). There is no uniformity in the textural and compositional characteristics of commercial artisan Servilleta cheese. Its moisture content is higher than that of other fresh goat's milk cheeses. It is soft, and its viscoelastic parameters showed high elasticity and a great fluid behavior. The high pasteurization temperature may affect moisture retention and textural properties.

	dry matter ¹		salt ¹		fracture force ²		fracture point ³		r	
	X̄	std	X̄	std	X̄	std	X̄	std	X̄	std
1	37.91 ^a	.77	.27 ^a	.02	16.18 ^a	1.79	44.65 ^a	1.34	.07 ^a	.0
2	37.78 ^a	.58	.56 ^b	.01	15.92 ^a	1.26	49.73 ^b	.95	.07 ^a	.0
3	43.69 ^b	.58	.72 ^c	.02	32.43 ^b	1.79	54.91 ^c	1.33	.08 ^b	.0

¹ (% in wet basis), ² (Newtons), ³ (distance in % of deformation); r reflects the #rate# at which the stress relaxes (r=0 in an ideal elastic body where stress does not relax); ^{a,b,c} values with the same letter within columns do not differ significantly (p<.05) by oneway ANOVA analysis.

Key Words: texture, cheese, goat

1258 Survivability of Probiotic Cultures in Symbiotic Goat's Milk Yogurt. Patricia Buldo*, Velitchka Gotcheva, and Mingrui Guo, *University of Vermont, Burlington VT.*

The ingestion of prebiotics and probiotics is proved to have a positive effect on maintaining healthy balance of the microflora in human digestive system. In this study, symbiotic goat's milk yogurt prototypes were prepared by combining probiotic cultures (*Lb. paracasei ssp. paracasei*, *Lb. acidophilus*, and *Bifidobacteria*) with prebiotic substances (fructooligosaccharose, FOS, and inulin). Changes in pH, titratable acidity (TA), and survivability of the probiotic cultures in six prototype yogurt products, i.e., control, fortified with goat's milk powder (4%), FOS (1 and 3%), and inulin (1 and 3%) were evaluated during nine-week refrigerated storage (4°C). Titratable acidity and pH were within the ranges of 1.11 to 0.89% and 4.26 to 4.06, respectively, throughout the period. Selective media (LP-MRS and B-MRS) were used to enumerate the viable cells of the probiotic strains during the storage. The effect of the prebiotics on the cultures was also studied. In all of the yogurt combinations, the three probiotic strains showed good survivability, starting at levels of 10⁹ CFU/g and decreasing to about 10⁷ CFU/g after 9 weeks of storage. The addition of milk powder seems to improve the viability of the probiotics compared to the other combinations. The survivability of the three strains varied, but, in general *Lb. acidophilus* and *Bifidobacteria* maintained higher concentrations than *Lb. paracasei ssp.*, except for the sample fortified with milk powder, in which *Lb. acidophilus* and *Lb. paracasei ssp.* showed better viability than *Bifidobacteria*. Chemical composition and the mineral profiles (Ca, K, Mg, Na, and Zn) of the six yogurt prototypes were also analyzed. There are no considerable differences in concentrations of all the minerals analyzed between

the control and the samples fortified with FOS, and inulin but the sample fortified with milk powder. In conclusion, the probiotic cultures in all prototypes remained at acceptable level ($>10^7$) for more than two months under refrigerated conditions. The addition of the prebiotic substances in the goat's milk yogurt seemed to have no positive impact on the survivability of the probiotic strains. The addition of milk powder contributed a better texture of the yogurt, as well as higher values of CFU/g.

Key Words: Pre-,probiotics, yogurt, goat's milk

1259 Protein profiles and rheological properties of fresh goat milk cheese. D. L. Van Hekken*¹, M. H. Tunick¹, and Y. W. Park², ¹USDA-ARS-ERRC, ²Fort Valley State University.

Soft fresh goat milk cheese is a highly valued dairy food, yet its production is limited by seasonal milk supply and its availability by short shelf-life. Protein profiles and rheological properties of the fresh cheese were determined to examine their variation during refrigerated storage. The cheeses were purchased from a commercial manufacturer within 24 hr of packaging and stored at 4°C for 7, 14, and 21 d. Protein extracts were prepared using either SDS or urea buffers, and protein profiles were examined using SDS-PAGE. Rheological properties were measured using a universal testing machine and a small strain oscillatory analyzer. Over the three week storage time, β -casein decreased approximately 10% with a concomitant increase in the β -casein fragments. During the three weeks of storage, rheological properties averaged 2.9 ± 0.5 N for hardness, 9.9 ± 0.4 mm for springiness, 21 ± 3 kPa for elastic modulus, 6.5 ± 0.9 kPa for viscous modulus, and 0.22 ± 0.03 kPa-s for complex viscosity. Only cohesiveness significantly changed over that time with a decrease from 0.25 to 0.12. Storage of fresh soft goat cheese at 4°C for up to 21d showed minimal changes. Protein profiles and cohesiveness were the best indicators of change in fresh soft goat milk cheese as it aged and may be useful in monitoring shelf-life.

Key Words: Goat Cheese, Rheology, SDS-PAGE

1260 Characterization of potential probiotic and milk fermenting properties of lactic acid bacteria strains. Velitchka Gotcheva*², Ely Hristozova³, Tsonka Hristozova⁴, Angel Angelov², Zlatka Roshkova², and Mingruo Guo¹, ¹University of Vermont, Burlington 05405, ²Higher Institute of Food and Flavor Industries, Plovdiv, Bulgaria, ³Medical Academy, Plovdiv, ⁴Institute of Microbiology, Plovdiv.

Several species lactic acid bacteria were isolated from a traditional Bulgarian cereal-based fermented beverage. These strains have been consumed for ages and proved to be safe. Two strains *Lb. plantarum* (B25 and B28), and one *Lb. casei ssp. pseudoplantarum* (B29) were studied in the present work for selected probiotic properties. Acid and bile resistance of the strains were evaluated. Results showed that the LAB tested are tolerant to low pH values (2.0-3.0) and bile concentration within 0.2-0.4%. Further, tests for antagonistic activity against some of the most common pathogens (*Salmonella*, *Pseudomonas*, *E. coli*, and *Enterococcus*) were carried out. *Lb. plantarum* B28 has a good antagonistic activity towards almost all the test-pathogens. Resistance of the LAB strains to the most commonly used antibiotics was also evaluated. Thirty-nine antibiotic compounds were used for the experiment. Strain *Lb. plantarum* B25 was resistant to 13 of them, and *Lb. plantarum* B28 was unaffected by 18 of the antibiotics. The third strain, *Lb. casei ssp.* was resistant to 16 of the substances tested. The potential use of the three LAB strains in milk fermentation was studied as well. They were tested for their ability to coagulate milk singly or in combinations. Fermentation trials showed that LAB at concentration 10^5 CFU/ml coagulated milk in about 10 h at 43°C. Incubation time varied for the three single strains and the combinations to clot the milk samples. *Lb. plantarum* strains had a faster rate of acid production than *Lb. casei ssp.* The combination of the three strains resulted in fermented milk with good texture and flavor. In conclusion, the LAB strains isolated from the cereal-based product have the potential to be probiotics. Further investigations are needed to evaluate other probiotic properties of the LAB strains and their milk coagulation characteristics.

Key Words: Lactic acid bacteria, probiotic properties, milk fermentation

1261 Melt and proteolysis of Mozzarella cheese as affected by starter culture and coagulating enzymes. P. Sharma*¹, R. I. Dave¹, K. Muthukumarappan¹, D. J. McMahon², and J. R. Broadbent², ¹MN-SD Dairy Center, South Dakota State University, Brookings, SD 57007, ²Western Dairy Center, Utah State University, Logan, UT 84322.

Low moisture part-skim Mozzarella cheeses were made to elucidate if the melt characteristics of mozzarella cheese were affected by starter cultures, or coagulating enzymes and how they were correlated with the proteolysis. Cheeses were prepared using single culture (SC) of *Streptococcus thermophilus*, or mixed culture (MC) of *Streptococcus thermophilus* and *Lactobacillus delbrueckii ssp. helveticus* using 1× or 6× of cheese coagulants, Rennet or Sure curd. Cheeses were analyzed for total solids, fat, protein, ash, salt, and calcium on day 1. Changes in melt characteristics and proteolysis during storage (4°C) were monitored on 1,7,15, and 30 days (d). The melt characteristics were measured using modified Schreiber test and SDSU-meltemeter (Creep test). Proteolysis was measured using capillary electrophoresis and soluble nitrogen. After 30 d storage, melt area as measured by modified Schreiber test increased only by ~2 times in cheeses made with ST as against ~3-4 times in the cheeses made with MC. On d 30, creep test showed that the fall in height increased by ~4-5 times in the SC cheeses but ~7-9 times in the cheeses made with MC, when compared with the values obtained on d1 for SC cheeses. Melt characteristics on d 7 for cheeses prepared with MC almost corresponded to that of d 30 cheeses made with SC; suggesting faster ripening and better improvement in the melt of cheeses made with MC. Soluble nitrogen was also higher in MC cheeses as compared to those made with SC only. The highest % breakdown of α_s casein was ~75% on d 30 in cheese samples prepared with MC using 6× rennet enzyme and that of β casein was ~50% in cheese samples prepared with MC using 6× sure curd. Results clearly indicated that selection of starter culture followed by type and concentration of coagulants were crucial in deciding the melt and rheology of part-skim Mozzarella cheese.

Key Words: Mozzarella cheese, Melt characteristics, Proteolysis

1262 Effects of Refrigerated Storage on Proteolytic and Lipolytic Properties of Soft Goat Milk Cheeses Manufactured in a Southern U.S. State. Aref Kalantari*¹, Young W. Park¹, and Diane Van Hekken², ¹Agricultural Research Station, Fort Valley State University, Fort Valley, GA, ²Eastern Regional Research Center, USDA/ARS, Wyndmoor, PA.

Information on shelf-life of commercial goat milk cheeses is extremely limited. Fresh soft goat cheeses were purchased from a commercial goat dairy manufacturer in a southeastern state, and stored at 4°C for 0, 7, 14, and 21 days for evaluation of shelf-life of the cheeses in relation to proteolytic and lipolytic parameters. One batch of the soft cheeses was frozen, stored for 3 months, thawed, and compared for the differences in shelf-life and storage quality between the fresh and frozen-stored products. Total N, percent water soluble N (WSN), pH and acid degree values (ADV) were determined, and protein profiles of fresh cheeses were examined using SDS-PAGE and densitometric analysis. The percent WSN ranged from 4.4 to 11.1 in the fresh cheeses for 3 weeks storage, and WSN increased with storage period, which occurred with the concomitant decrease in beta-casein as revealed in the SDS-PAGE and densitometric results. There was a greater increase in WSN in frozen-stored cheeses than that in the fresh counterparts, suggesting that frozen-storage and thawing accelerated protein degradation in the frozen thawed cheeses, presumably due to the denaturation of cheese proteins as well as activation of some proteinase enzymes. The mean ranges of pH for the testing period in both fresh and frozen-stored cheeses were 4.14 to 4.81, and tended to decrease with storage times. ADVs were significantly increased with time, especially at 21 days. ADVs were higher in the frozen-stored cheeses than fresh ones. It was concluded that the food quality of the soft goat cheeses had begun to deteriorate significantly at 21 days refrigerated storage especially when the sealed packages were open and stored, as evidenced by the elevated proteolytic and lipolytic indices.

Key Words: Soft goat cheese, storage, shelf-life, proteolysis, lipolysis

1263 Fluid milk quality: Microbiological analysis of fluid milk at the carton encoded sell by date. T.J. Pritchard*¹ and P.S. Kindstedt¹, ¹ *Northeast Dairy Foods Research Center, University of Vermont.*

The objectives of our study were to evaluate the temperature of dairy display cases and to determine the microbiological load of fluid milk at the carton-encoded sell by date. A total of 211 reduced fat fluid milk samples were obtained from 174 dairy display cases throughout Northern New England. Stores evaluated ranged from small mom and pop stores to large multi-state chain stores. Dairy display case temperatures were obtained by recording the temperature of product present in the case. Samples were packaged in ice during transport back to the lab. Milk samples were maintained at 38F or below until the sell by date. Milk samples were diluted in a peptone-NaCl solution and evaluated utilizing both 3M APC Petrifilms and 3M coliform Petrifilms. The temperature of the display cases ranged from 33F to 53F. One hundred forty-two of the coolers registered temperatures at or below the US Food Code designated upper limit of 45F while 32 of the coolers registered temperatures above 45F. The aerobic plate count of the samples ranged from a low of <1 to a high of >10⁸ CFU/ml. Sixty-eight of the samples were still within Pasteurized Milk Ordinance standards at their sell by date. Two-thirds of the samples, 143 of 211, failed to meet the requirements for fluid milk outlined in the PMO. The majority of the sample which failed PMO standards, 111 of 136, contained 10⁶ CFU/ml or more. Eight of these samples contained greater than 10⁸ CFU/ml. Analysis of 210 of the milk samples for the presence of coliform bacteria indicated that 90% of the samples, 189 of 210, were at or below the PMO limit for pasteurized fluid milk. Twenty-one samples contained >10CFU/ml of coliform bacteria. Within the samples that failed, counts ranged from 11CFU/ml to >10³ CFU/ml. The results of our survey indicate that dairy display cases are a potential site for temperature abuse of fluid milk which require further scrutiny. Furthermore, the sell by date encoded on packages of fluid milk does not necessarily indicate the microbiological quality of the product contained within.

Key Words: Milk Quality, Microbiology, Shelf-life

1264 Linoleic acid isomerase activity in *Lactobacillus acidophilus* and *Propionibacterium freudenreichii* subsp. *shermanii*. T Lin*¹, C Lin², and Y Wang², ¹ *Chinese Culture University*, ² *National Taiwan University.*

Crude protein extracts of *Lactobacillus acidophilus* (CCRC14079) and *Propionibacterium freudenreichii* subsp. *shermanii* (CCRC11076) were reacted with linoleic acid at 50°C for 10min at pH 5, 6, 7, and 8, and the levels of conjugated linoleic acid (CLA) isomers formation were determined by high performance liquid chromatography. The activity of linoleic acid isomerase was observed in >100 Kd crude protein filtrates of both culture extracts, as evidenced by the formation of conjugated linoleic acid isomers after the reaction. The filtrate of *L. acidophilus* produced more CLA (1125.63 µg /mg protein) than *P. freudenreichii* subsp. *Shermanii* (620.89 µg /mg protein). Higher levels of CLA isomers were formed at pH 5 of *L. acidophilus* treatment. However, no significant difference in CLA formation was observed among four pH treatments of *P. freudenreichii* subsp. *Shermanii*. While the amounts of eight CLA isomers produced varied with culture and pH, more c10,t12-CLA was formed, followed by c9,t11-CLA, in most of the treatments.

Key Words: Conjugated linoleic acid, Isomerase, *Lactobacillus acidophilus*

1265 Comparison of effect of vacuum condensed and ultrafiltered milk on Cheddar cheese quality. M. R. Acharya* and V. V. Mistry, *MN-SD Dairy Foods Research Center, South Dakota State University, Brookings.*

Raw whole milk was separated to approximately 0.4% fat, pasteurized and split in 3 parts. One part (175 kg) was vacuum condensed to 11-12% protein (CM) and another (175 kg) was ultrafiltered to 15-16% protein (UF). The third part, pasteurized cream and CM or UF were blended to casein to fat ratio of 0.7 and protein of 4.5% (UF1 and CM1) and 6.0% (UF2 and CM2). No concentrate was added to the control (C), 3.2% protein. Total quantity of blended milk was 100 to 105 kg for C, 72.5 kg for UF1 and CM1 and 54.5 kg for UF2 and CM2. Cheddar cheeses (5 replicates) were made using frozen concentrated starter (7g/kg protein

in cheese milk) and rennet (9ml/45.4 kg milk for C and 6ml/45.4 kg milk for the concentrates). At 1 wk, the moisture content of Cheddar cheeses was 39.2 (C), 37.8 (UF1), 36.5 (UF2), 38.5 (CM1) and 36.7% (CM2). At 12 wk it had dropped to 38.8 (C), 37.3 (UF1), 35.6 (UF2), 37.7 (CM1) and 35.5% (CM2). The fat content ranged from 31.5 to 32.4% and salt from 2.05 to 2.14% with no significant differences between treatments. Calcium content was higher in UF cheeses (0.75%-UF1 and 0.79%-UF2) than CM cheeses (0.71%-CM1 and 0.76%-CM2) followed by C (0.68%) and it increased with protein content in cheese milk. UF milk produced cheese with higher protein content (25.6%-UF1 and 26.4%-UF2) than CM milk (24.7%-CM1 and 25.4%-CM2). The soluble protein content of all cheeses increased during 12 wk of ripening. Control cheeses exhibited the highest extent of proteolysis followed by treatments with 4.5 and 6.0% protein in cheese milk, respectively. CM cheeses exhibited higher level of proteolysis than UF cheeses. Counts of lactic starters were in the range of 9-10 logs at 1 wk, which reduced to approximately 6-7 logs after 12 wk, and the counts of non-starter lactic acid bacteria were about 2-3 logs at 1 wk and increased to 4-5 logs after 12 wk, but there were no differences in the counts among treatments. These cheeses will be used for process cheese manufacture.

Key Words: Vacuum condensing, Ultrafiltration, Cheddar cheese

1266 Comparison of rennet curd formation characteristics of milk concentrated by vacuum condensing and ultrafiltration. V. V. Mistry*, P. Upreti, and M. R. Acharya, *MN-SD Dairy Foods Research Center, South Dakota State University, Brookings.*

Raw whole milk was separated to 0.4% fat, pasteurized and split into three parts. One part was vacuum condensed to 11-12% protein (CM), and another ultrafiltered to 15-16% protein (UF). The third part, pasteurized cream, and CM or UF were blended to casein to fat ratio (CF) of 0.7 and protein of 4.5% (CM1 and UF1) and 6% (CM2 and UF2). The control (C) was a blend of milk and cream with no concentrate and CF of 0.7 and 3.2% protein. A Formagraph was used to determine rennet clotting time (RCT), amplitude (or curd firmness) at 40 min, (A40), and time to achieve amplitude of 20 mm (k20). Rennet was added at 9-mL/45.4 kg milk and with no starter added. The RCT for C was 33.3 min. It was lower for CM than for UF and for 6% protein than for 4.5%. The k20 for 3.2, 4.5 and 6% protein was 43.5, 8.4 and 4.3 min, respectively, and was not affected by method of concentration. The A40 was dependent on protein (3, 35 and 54 mm for 3.2, 4.5 and 6% protein, respectively) and milk (46 mm, CM and 44 mm, UF). A Brookfield viscometer equipped with a UL adapter was used under a constant rate of strain of 1/306 s to determine viscosity every minute for 40 min at 32°C after addition of starter (same rate as in cheese making) and rennet at 6 and 9-mL/45.4 kg milk. There were three distinct phases. In the first phase there was no change in viscosity. This initial viscosity increased with protein and was higher for the CM than for the UF milk for the same protein content. In the second phase there was a sharp increase until a maximum was reached. In the third phase there was a decline in viscosity. Viscosity began to increase approximately 7 min earlier for samples with 9 mL rennet than with 6 mL. The time at which the maximum viscosity occurred was affected by amount of rennet and occurred earlier in UF than in CM. The maximum viscosity depended on protein content and method of concentration (23.2-CM2, 16.5-UF2, 10-CM1, 8.5-UF1, 5.1 mPa.s- C). For the same protein content maximum viscosity was lower for UF milks than CM.

Key Words: vacuum condensing, ultrafiltration, rennet coagulation

1267 Standardization of cheesemilks using cold ultrafiltration retentates for the manufacture of Parmesan cheese. J.J. Jaeggi*¹, S. Govindasamy-Lucey¹, M.E. Johnson¹, and J.A. Lucey², ¹ *Wisconsin Center for Dairy Research, University of Wisconsin, Madison, Wisconsin/USA*, ² *Department of Food Science, University of Wisconsin, Madison, Wisconsin/USA.*

Milk for Parmesan cheese is generally standardized by cream removal. This method of standardization and the low fat and moisture contents of Parmesan cheese results in low yield efficiency. The addition of NFD is not usually practiced because of increased concentration of residual sugar in the cheese. One solution to the problem of lower cheese yield efficiency, and one that would overcome the problem of excessive residual sugar, is the use of UF milk. Milks concentrated by cold UF (<7C) were used to manufacture Parmesan cheese. Milks for cheesemaking were made by blending cold (whole milk) UF retentates (26% solids)

with partially skimmed milk (1.0% fat) to obtain blends with 14.5% solids and a casein:fat ratio of 1.1. A second approach was used where skim milk was concentrated by cold UF to 26% solids and blended with partially skimmed milk (3.4% fat) to obtain blends with 14.5% solids at a casein:fat ratio of 1.1. Control milks were partially skimmed to a casein:fat ratio of 1.1 and total solids of 11.3%. Traditional Parmesan manufacturing protocol was followed. Setting times were 16 and 22 min for experimental and control milks, respectively. Following brining for 70 h, the cheeses were dried at 60% relative humidity and 12C in a commercial Parmesan drying facility until a target moisture of around 32% was reached. As expected, cheese yields were higher in the higher solids milks (12-13%) compared to control cheese (7.5%) due to higher protein and fat levels in the cheesemilk. However, there were higher fat losses in the whey, derived from milk blended with whole milk UF retentates, possibly due to fat damage during the UF process. Higher protein recoveries were obtained in cheeses manufactured using cold UF retentates. There was no difference in the pH (5.14-5.15) and moisture contents (40.1-40.6%) of the cheeses prior to brining. No residual lactose or galactose was left in the cheeses. Experimental cheeses had higher moisture contents (33.0-35.2%) than control cheeses (32%) after drying for 9 weeks. It appeared to be more difficult to dry cheeses made from the higher solids cheesemilks, probably due to an altered structure in these cheeses. The use of milk concentrated by cold UF appears to be a promising way of improving the yields of Parmesan cheeses.

Key Words: Ultrafiltration, Parmesan cheese, Standardization

1268 Modulation of colonic microbiota with sweet bifidus milk. Elisa Teshima¹, Celia L. L. F. Ferreira^{*1}, Neuza M. B. Costa¹, Ferlando L. Santos¹, and Izabele D. P. Marliere¹, ¹Federal University of Viosa.

The human gastrointestinal tract constitutes a complex microbial ecosystem and colon is the most heavily colonized region. Through the process of fermentation, colonic bacteria are able to produce a wide range of compounds that have both positive and negative effects on the gut physiology. Therefore, there is some interest in manipulation of the composition of the gut microbiota towards a more salutary regimen, increasing the numbers and activities of bacterial groups such as bifidobacteria and lactobacilli. One of approaches to increase the number of these organisms in the gut is through the oral administration of live, beneficial microbes, termed probiotics. Dairy products are the most common carriers of probiotic organisms, mainly in fluid milk, yogurt or fermented milk. Although many products have been commercialized, few probiotics strains were analyzed for its ability of modification on the microbiota composition. New isolates of *Bifidobacterium breve* from neonates were selected in our laboratory, with high resistance to gastric juice and bile salts, therefore suitable candidates for use as probiotics. The purpose of this study was to elucidate effects of sweet bifidus milk containing a pool of these bacteria in cecal and colonic microbiota levels in rats. Twenty female adults Wistar rats were randomly assigned to one of two treatments: 1) control diet (AIN-93 diet for rodents) or 2) control diet + sweet bifidus milk (Log 8 cfu/ml). The duration of the study was 28 days. The cecal and colonic content was analyzed for total anaerobes, bifidobacteria, total aerobes, lactobacilli and *E. coli* using selective media. The consumption of sweet bifidus milk resulted in higher bifidobacteria levels in cecum (Log 8.28 cfu/ml) and colon (Log 8.49 cfu/ml) when compared to levels in cecum (Log 6.55 cfu/ml) and colon (Log 7.06 cfu/ml) of control group (P<0.01). The total anaerobes and aerobes levels were not affected (P>0.05) by the treatment in both segments of the gut. The numbers of *E. coli* were lower (P<0.05) in cecum, but not in the colon of probiotic feed animals. Inversely, the numbers of lactobacilli were lower (P<0.05) in the colon but not in the cecum. Therefore the consumption of sweet bifidus milk may be beneficial in improving gastrointestinal health.

Key Words: Bifidobacteria, Microbiota, Rats

1269 Structural and functional properties of a small cryptic plasmid of *Streptococcus thermophilus*. G.A. Somkuti and D.H. Steinberg, Eastern Regional Research Center, ARS-USDA.

A small cryptic plasmid designated as pER13 was isolated from the lactic starter bacterium *Streptococcus thermophilus* strain ST113. The complete sequence of pER13 was 4137 bp with five distinct open reading frames (ORFs), some sharing a high level of homology with ORFs of the pMV158 family plasmids found in *S. suis* (SS) and *S. agalactiae* (SA), clinical streptococci which cause diseases in domestic animals and humans. In *S. thermophilus*, ORF1 encodes a 45-residue protein that

is identical to the CopG protein in plasmids of SS (pSSU-1, 4.9 kb) and SA (pMV158, 5.5 kb). The ORF2 (*rep*) encodes a 179-residue protein, shorter than but with high level of homology to the RepB proteins found in the other two species. In addition, the 500-amino acid protein encoded by ORF3 is highly homologous to the mobilization proteins (Mob) encoded on the SS and SA plasmids. The presence of a *mob* gene in pER13 allows its mobilization and transfer into new hosts by functions of conjugative plasmids in the pIP501-pAM β 1 family. When one of these plasmids is electrotransformed into ST113, the subsequent co-transfer of pER13 and pIP501 into lactococci occurs by a conjugative process, possibly involving the formation of a cointegrate as shown by agarose gel electrophoresis. This permits the development of pER13 as a cloning vector and offers another approach to introducing new genetic functions into lactic fermentation bacteria. The presence of several highly homologous ORFs in *S. thermophilus*, SS and SA also implies the possibility of horizontal gene transfer between clinical and nonclinical species of streptococci.

Key Words: Plasmid, *Streptococcus thermophilus*

1270 Production and functional properties of dairy products fermented with probiotic bacteria. Sharareh Hekmat^{*}, Brescia College at University of Western Ontario.

The concept of probiotics which is the use of bacteria to enhance health has gained increased interest in the dairy food industry. *Lactobacillus acidophilus* and *Bifidobacterium bifidum* are two examples of probiotic bacteria that could be delivered to consumers through fermented dairy products. Some of the potential benefits of these bacteria are maintaining optimal balance of microbial organisms, and producing antibiotics, organic acids and *B*-galactosidase in the intestine. Many dairy products such as milk, yogurt, frozen yogurt, carbonated liquid yogurt, and ice cream could be fermented with these bacteria. This paper reviews the production of different probiotic dairy foods, the survival rate of these bacteria during manufacture and storage, the enumeration techniques, and the optimum growth condition in terms of pH, nutrients, and temperature. It will also examine *B*-galactosidase activity during storage and sensory properties of these fermented dairy products.

Key Words: Probiotic bacteria, Fermented dairy products

1271 Changes in functionality of Mozzarella cheese produced from bovine and caprine milk during refrigerated storage. E. J. Oh¹, J. Y. Imm^{*2}, K. S. Han¹, J. S. Kim², S. Oh³, and S. H. Kim¹, ¹Korea University, ²Korea Food Research Institute, ³Korea Yakult Co. Ltd..

Up to present, only limited information is available for functionality of caprine Mozzarella cheese (MC). The objective of this study was to compare functionality of caprine MC with bovine MC during refrigerated storage. Low moisture part skim MC was prepared from fresh bovine and caprine milk using commercial starter and rennet. Changes in meltability, free oil, browning, texture characteristics and microstructure was monitored for 8 weeks. Proteolysis was determined by measuring 12% TCA and pH 4.6 soluble nitrogen and relative degradation of major caseins was quantified by SDS-PAGE and densitometric scanning. The data were analyzed by ANOVA using PROC GLM of SAS and Duncan's multiple comparison test. Largest increase in meltability was found at early refrigerated storage from 1 to 7 days both for bovine and caprine MC. Except the first day, meltability did not show significant difference between bovine and caprine MC during storage. Bovine MC formed significantly higher amount of free oil than that of caprine MC throughout storage. The major decrease of TPA hardness in bovine MC occurred between 2 and 4 weeks storage, but hardness of caprine MC gradually decreased throughout the storage. Although bovine MC appeared to have denser protein matrix at early storage (2 weeks), degradation of protein matrix in bovine MC was much greater than caprine MC for more than 4 weeks storage. Significantly higher soluble nitrogen content of bovine MC in 12% TCA or pH 4.6 acetate buffer indicated that greater extent of proteolysis was occurred in bovine MC during the storage. Breakdown of α_{s1} -casein was dominant in the storage of bovine MC and only 65% of α_{s1} -casein was remained after 8 weeks storage. For caprine MC, β O-casein showed major change and 77% of initial β O-casein was remained intact. When MC was baked bovine MC showed significantly higher brown color intensity than that of caprine MC throughout the storage. The intensity of brown color was not significantly affected by storage period for caprine MC.

Key Words: Mozzarella cheese, caprine milk, functionality

1272 Effect of *Lactococcus lactis* ssp. *lactis* ml3 and c2 bacteriophage peptides and *Lactobacillus plantarum* yit0068 bacteriophage peptides on the growth of *L. lactis* ssp. *lactis* C2 and the inhibition of ml3 and c2 bacteriophage proliferation. C. Hicks*¹, I. Surjawan¹, N. Jose¹, C. Jose², and B. Barlow¹, ¹University of Kentucky, Lexington, Kentucky, ²University of Riau, Pekanbaru, Indonesia.

Phage-peptides were prepared from *L. lactis* ssp. *lactis* ml3 and *L. plantarum* yit0068 bacteriophage using a ficin hydrolysis. The ml3 and yit0068 peptides were compared to *L. lactis* ssp. *lactis* c2 bacteriophage peptides to determine growth inhibition of C2 host and inhibition of both ml3 and c2 bacteriophage. M17 with .011 mM CaCl₂ media with and without phage peptides (2 or 2.5%) were heat treated, cooled to 22°C, inoculated with C2 host, and infected with ml3 or c2 bacteriophage at 0, 10², 10⁴, 10⁶, or 10⁸ pfu/mL. Culture growth and lysis were monitored spectrophotometrically (λ_{600nm}) for 6.5 h. Growth of C2 culture in ml3 or yit0068 peptide media was dramatically slower and cell density was lower at the stationary phase than when the culture was grown in a medium without peptides. Growth time to the stationary phase was essentially the same for media with and without peptides added. C2 culture grown c2 peptide medium was not significantly inhibited. When C2 culture was grown in medium containing ml3 or yit0068 peptide there was little inhibition of ml3 bacteriophage proliferation. When the medium contained c2 peptide the ml3 bacteriophage proliferation could be partially inhibited. When C2 host was grown in media containing ml3 peptide and infected with c2 bacteriophage only a slight inhibition of bacteriophage proliferation occurred. However, c2 bacteriophage proliferation was inhibited when C2 host was grown in media containing yit0068 or c2 peptide. Culture growth (C2) was extended by 20 and 50 min before the culture started to lyse when infection levels were 1 x 10³ pfu/mL and 1 x 10⁴ pfu/mL, respectively. Lysis did not occur when C2 culture was grown in media containing c2 or yit0068 peptide and infected with 1 x 10² pfu/mL of c2 bacteriophage. These data suggest that the best growth medium and phage inhibitory medium was the medium that contained the c2 bacteriophage peptide.

Key Words: *Lactococcus lactis* ssp, bacteriophage inhibition, ml3, yit0068, c2.

1273 Effect of black pepper essential oils and orange peel terpenes on the inhibition of *Lactobacillus plantarum* and the inhibition of *L. plantarum* yit0068 bacteriophage proliferation. C. Jose¹, N. Jose², C. Hicks*², and I. Surjawan², ¹University of Riau, Pekanbaru, Indonesia, ²University of Kentucky, Lexington, Kentucky.

Effect of essential oils of black pepper and orange peel terpenes on the growth of *L. plantarum* and proliferation of yit0068 bacteriophage was determined collaboratively at University of Kentucky and University of Riau. Orange peel terpene and Indonesian extracted black pepper essential oils were used to determine the concentration that would allow the growth of *L. plantarum* but inhibit the proliferation of yit0068 bacteriophage. Bacteriophage inhibition tests were done by growing *L. plantarum* (4%) in MRS medium (25 ml) containing .011 mM CaCl₂ with and without terpenes (0, 5, and 25 ppm) at 35°C. One half of the media were infected with *L. plantarum* yit0068 bacteriophage (0.01%; 1 X 10⁸ pfu/ml) after 1 h of incubation or after 0.1 increase in absorbance (λ_{600nm}). Dilutions were made by dissolving the essential oil stock in 1,2 -propanediol. Cell growth and lysis was spectrophotometrically observed (λ_{600nm}) after inoculation for up to 6 h at 10 min intervals. Other studies (in Indonesia) of essential oils of black pepper fractionated using n-hexane or methanol were conducted in a similar manner, except that the concentration of the oil fraction in the media were 1.0, 1.5, 2.0, and 2.5 %. Results from both laboratories suggested that essential oil of black pepper, its fractions (n-hexane and methanol extracts) and orange peel terpene were effective inhibitors of culture growth at the concentrations tested. Both laboratories confirmed that there was no concentration of black pepper essential oil nor orange peel terpene where *L. plantarum* grew that yit0068 bacteriophage was inhibited. These negative results do not agree with a previous study suggesting that black pepper essential oils are inhibitory to *L. plantarum* bacteriophage proliferation during vegetable fermentations.

Key Words: *Lactobacillus plantarum*, yit0068 bacteriophage, essential oils, black pepper, terpenes, inhibition

1274 Estimation of vitamin D₃ content in process cheese. P. Upreti*¹, V. V. Mistry¹, and J. J. Warthesen², ¹MN-SD Dairy Foods Research Center, South Dakota State University, Brookings, ²University of Minnesota, St. Paul.

The goal of this project is to develop a procedure for the fortification of process cheese with vitamin D₃. To monitor the vitamin D₃ content of this process cheese a high-performance liquid chromatographic (HPLC) method was developed and is presented here. 4 to 5 g of shredded cheese sample was saponified in a low-actinic Erlenmeyer flask using 20-mL KOH (60%) and 20-mL ethanol (95%) at 70°C for 30 min in the presence of 50 mL of 6% ethanolic pyrogallol as an antioxidant. The unsaponifiable matter from cheese was extracted using a mixture of petroleum ether (90 parts) and diethyl ether (10 parts). The ether layer was washed with ice-cold water until neutralization. It was then separated and partially dried in a rotary evaporator, and then completely dried under nitrogen. The dried extract was reconstituted in 3-mL hexane and applied to a 1-mL silica cartridge for solid phase extraction. Vitamin D₃ was eluted with 5-mL of a mixture of hexane (21.5 parts) and chloroform (78.5 parts). The eluent was evaporated to dryness under nitrogen and reconstituted in 2-mL acetonitrile. Of this 100 μ L was injected into the HPLC. The HPLC system included a C₁₈ liquid chromatographic column (4.6-mm ID x 15 cm, 5- μ m particle size) with UV detection at 254 nm and a flow rate of 1 mL/min. A mixture of acetonitrile and methanol in the ratio of 30 to 70 was the mobile phase. This ratio was selected on the basis of satisfactory resolution of vitamin D₃ and separation of the vitamin from interfering shouldering peaks. Vitamin D₃ eluted at approximately 9 min. A standard curve of vitamin D₃ was prepared by adding known quantities of crystalline vitamin D₃ to the cheese at six levels (0, 4.46, 8.93, 17.86, 26.79, 35.71 IU per 5 g of cheese) and quantitated using the above procedure. This was replicated five times. The standard curve had a r² of 0.9722. The method can be used to assess the process cheeses fortified with vitamin D₃. Process cheeses fortified with Vitamin D₃ will be manufactured and the above procedure will be used for quantification.

Key Words: vitamin D, process cheese, HPLC

1275 Cheese treated by high pressure in an early stage of ripening. Changes in textural attributes. J. Saldo¹, E. Sendra*², and B. Guamis¹, ¹Planta de Tecnologia d'Aliments, UAB. CeRTA. XiT. Bellaterra, Spain, ²Divisin de Tecnologia de Alimentos. Universidad Miguel Hernandez. Orihuela, Spain.

High pressure (400 MPa, 5 min) was applied to cheese the day after salting in brine to promote accelerated ripening. The high pressure treatment (HPT) caused changes in cheese texture. The extent of these changes and its evolution along ripening will be studied. Two batches of Garrotxa cheese were manufactured. This is a mixed curd, uncooked, pressed, goat milk cheese. Uniaxial compression and stress relaxation tests were performed on cylindrical cheese samples (2.54 cm diameter and 2 cm height) and replicated 6 times for each cheese piece. All parameters measured from uniaxial compression test were different between treatments (p<0.05). Stress at breaking point (σ_f) and at maximum strain ($\sigma_{0.7}$) decreased in treated samples, while strain at breaking point (ϵ_f) was higher. The adherence of samples to the probe (σ_{ad}) was higher for treated cheeses. HPT cheese became softer and yielding, with an increased adherence. Stress relaxation was modelised using a linear model which parameters are k₁ and k₂, according Peleg & Normand (1983). Moisture in HPT samples were higher than in control ones and proteolysis was increased too. This would help those changes in texture. Multivariate analysis discriminate between young and old cheese along first principal component. Dramatic changes were observed after day 30 of ripening. Second principal component discriminate between treatments. σ_f , ϵ_f and $\sigma_{0.7}$ were significant for PC1, while σ_{ad} , k₁ and k₂ were significant for PC2.

	σ_f	(N)	ϵ_f	(-)	$\sigma_{0.7}$	(N)	σ_{ad}	(N)
	Ctrl	HPT	Ctrl	HPT	Ctrl	HPT	Ctrl	HPT
day 3	37.6 ^a	30.3 ^b	0.332 ^a	0.430 ^b	25.3 ^a	20.5 ^b	-0.187 ^a	-0.602 ^b
day 7	47.9 ^a	47.5 ^a	0.282 ^a	0.356 ^b	37.2 ^a	30.7 ^b	-0.189 ^a	-1.695 ^b
day 14	50.3 ^a	63.4 ^b	0.282 ^a	0.326 ^b	37.3 ^a	41.5 ^b	-1.017 ^a	-1.955 ^b
day 21	69.7 ^a	55.3 ^b	0.245 ^a	0.320 ^b	51.4 ^a	33.7 ^b	-0.949 ^a	-2.831 ^b
day 30	74.6 ^a	44.1 ^b	0.281 ^a	0.317 ^b	46.6 ^a	27.4 ^b	-0.817 ^a	-1.484 ^b
day 45	125.6 ^a	76.7 ^b	0.243 ^a	0.253 ^a	88.2 ^a	48.6 ^b	-3.440 ^a	-4.389 ^a
day 60	132.9 ^a	99.9 ^b	0.231 ^a	0.263 ^b	90.3 ^a	60.7 ^b	-3.960 ^a	-5.226 ^a

Uniaxial compression parameters along ripening time. Values with the same letter within the same row for each parameter do not differ significantly ($p < 0.05$) by two way ANOVA analysis (batch and treatment).

Key Words: High Pressure, Goat Cheese, Texture

1276 Cheeses of Spain: classification and description. M. Almena Aliste^{*1,2}, A. Cepeda Sez¹, and Y. Nol², ¹*Hygiene and Food Inspection, Faculty of Veterinary Lugo-University of Santiago de Compostela, Spain*, ²*INRA Dairy Technology and Analysis Research unit Poligny, France*.

In Spain there are more than 100 varieties of traditional cheeses. Eleven such cheeses already carry the quality label of origin "Protected Designation of Origin" (PDO), and other six denominations have recently been submitted. However, Manchego cheese is the only internationally known cheese from Spain. The diversity of the cheese varieties makes the classification of Spanish cheeses difficult. Furthermore, a one-dimensional classification based on a single criterion would be insufficient and confusing. This work showed the great variety of cheeses from Spain by using two kinds of classifications that combine different criteria: origin of milk, technology of elaboration and cheese characteristics (composition, texture and other key properties). The study was completed with a table that closely described the main properties of the current PDO-Spanish cheeses: *Tetilla*; *Cabrales*; *Picn Bejes-Tresviso*; *Quesucos de Libana*; *Cantabria cheese*; *Idizabal*; *Roncal*; *Zamorano*; *Mahn*; *Manchego*; *Majonero* and *La Serena* cheese. The approach used allows a general but precious overview of the cheeses manufactured in Spain and illustrates possible strategies for classifications that could be applied to other cheeses.

Key Words: Cheeses from Spain, Multidimensional Classification, Description

1277 Stress relaxation test: an approach to study cheese openness. C. Achilleos, M. Almena Aliste*, and Y. Nol, *INRA Dairy Technology and Analysis Research unit Poligny, France*.

The quality of Comt cheese is determined not only by flavor and texture but also by openness: few eyes, slits, or none (blind cheese). In order to investigate mechanisms of eye development, we need instrumental methods to characterize the mechanical properties of cheese, which affect eye development. Stress relaxation tests at different initial deformation levels (from 5% to 60%) were evaluated with 3 Comt cheeses in comparison with uniaxial compression at constant displacement rate. Each cheese selected had a typical openness, either eyes, or slits or none. For stress relaxation, the initial compression that appeared interesting for the characterisation of the mechanical properties was 20%, which was large enough to avoid errors due to sampling while cracks did not develop in the samples. At this initial deformation level, stress relaxation allowed a quite good characterisation of the cheeses with the 3 typical openness (84.6% of the observations were well classified). Nevertheless, compression test allowed the best discrimination between the 3 types of Comt cheeses with 100% of the observations well classified. A set of 30 experimental Comt cheeses was analysed to evaluate the stress relaxation as a method to characterize the mechanical properties in relation with openness. The well classified cheeses represented 73.3% of the whole set. Stress relaxation provided promising results since the set of cheeses had complex openness associating slits and eyes.

Key Words: Relaxation and compression tests, Openness, Comt cheese

1278 Evaluation of reduced fat Cheddar cheese made with attenuated and not attenuated adjunct culture of *Lactobacillus helveticus* I: Effect of make procedure and cell attenuation. S.A. Madkor¹, P.S. Tong^{*1}, and M. El-Soda², ¹*California Polytechnic State University*, ²*Alexandria University*.

Adjunct culture of *Lb. helveticus* I was selected for evaluation in stirred and milled curd reduced fat Cheddar cheese making trials. *Lb. helveticus* I was cultivated in MRS broth and harvested by centrifugation at 4°C (4000 g for 30 min). A portion of the culture suspension was attenuated by freeze shocking at -20°C. Untreated (not attenuated), freeze-shocked or untreated/freeze-shocked mixture of *Lb. helveticus* I cells were inoculated (10^8 cfu/gm) in the starter-treated cheese milk prior to rennet coagulation. Inoculation of adjunct did not affect the manufacturing parameters in stirred or milled curd cheese. Cell counts of both

Lactococcus on M17 agar and *Lactobacilli* on Rogosa agar were determined after one day of ripening and monthly for 6 months thereafter. The viable count of *Lactobacilli* in one day cheese was lower than the number expected to be retained in cheese possibly due the loss of culture cells in the whey during cheese processing. The number of *Lactobacilli* increased up to the third month of ripening and slightly decline thereafter. The rate of *Lactobacilli* reduction was greater in cheese made with freeze-shocked *Lactobacilli*. Cheeses made with adjunct *Lb. helveticus* I showed higher levels of proteolysis as indicated by FAA levels with the progress of ripening when compared to control cheese without adjunct. A slightly higher level of free amino acids were observed in stirred curd cheese compared to milled curd cheeses. Taste panel results indicated addition of *Lb. helveticus* adjunct culture to milled or stirred curd reduced fat Cheddar cheese positively influenced the flavor/aroma score and prevented bitterness throughout the entire ripening period. This effect was most pronounced in cheese treated with a mixture of untreated and attenuated adjunct cultures. The general conclusion reached from this work indicate that we believe that *Lb. helveticus* I adjunct will lead to enhanced and improved flavor quality in stirred or milled curd reduced fat Cheddar cheese.

Key Words: Cheddar, cheese, adjunct

1279 Genetic typing of Swiss cheese starter culture strains by pulsed field gel electrophoresis and arbitrarily primed-PCR. J. K. Jenkins*, W. J. Harper, and P. D. Courtney, *The Ohio State University Columbus, Ohio*.

The manufacture of Swiss cheese requires growth of three bacterial species, *Propionibacterium freundenreichii*, *Lactobacillus helveticus* and *Streptococcus thermophilus*. Two genetic typing methods were compared for their ability to discriminate between strains of each species. Isolated colonies from single and multiple strain cultures were obtained on appropriate selective media. For multiple-strain cultures, ten to twenty single colonies were typed by one or both methods to separate the strains. The arbitrarily primed-PCR (AP-PCR) was performed at three annealing temperatures, 38, 40 and 42°C as described by Cusick and O'Sullivan (Appl. Environ. Microbiol. 66:2227-2231), followed by electrophoresis of products. Pulsed field gel electrophoresis (PFGE) was used to analyze *Apa*I and *Sma*I digestions of *Lactobacillus* and *Streptococcus* genomes and *Spe*I digestions of *Propionibacterium* genomes. Other enzymes or enzyme combinations tested for *Propionibacterium* genome digestion (*Apa*I, *Bam*HI, *Bgl*II, *Cla*I, *Eco*RV, *Hind*III, *Pst*I, *Sma*I and *Sph*I) were unable to yield the appropriate number of fragments for analysis. Of the nine *S. thermophilus* strains analyzed, AP-PCR distinguished six electrophoretic patterns. PFGE of both *Apa*I and *Sma*I digestions revealed eight distinct patterns with two strains having identical patterns. The results with all three species indicate that pulsed field gel electrophoresis, though more labor intensive, is more effective at discriminating between strains than AP-PCR.

Key Words: Lactic acid bacteria, Pulsed field gel electrophoresis, Arbitrarily primed-PCR

1280 Salt tolerance of dairy propionibacteria. O. Anggraeni, J. K. Jenkins*, and P. D. Courtney, *The Ohio State University Columbus, Ohio*.

Propionibacterium species are required to produce the characteristic appearance and flavor of Swiss cheeses. Differences in salt tolerance among propionibacteria strains may influence strain performance depending on conditions in a specific cheese. Many bacteria can import compatible solutes, such as betaine and proline, to counteract the effects of high osmotic pressure in the environment. Six strains of *Propionibacterium freundenreichii* were grown in a minimal defined medium with various levels of NaCl for seven days at 28°C, anaerobically. Growth was monitored by measuring culture turbidity (absorbance at 600 nm). All strains grew in the minimal medium without salt, though the lag phase varied among the strains from one to four days. 1% NaCl extended the lag phase of all strains by approximately one day and reduced the maximum cell density reached by four of the strains. Growth of three strains was completely inhibited by 2 and 3% NaCl. Two strains had markedly suppressed growth at these concentrations. One strain, P273, was able to reach the same cell density in 2% salt as in the absence of salt, though with an extended lag phase. In medium containing 3% salt, strain P273 grew at a significantly faster rate than the other five strains. No significant growth of any strain was observed at salt concentrations

of 4, 5, 6 and 7%. Betaine (1 mM) or proline (5.9 mM) was added to each growth medium to assess their effectiveness as osmoprotectants. Neither betaine nor proline improved growth of four of the strains at any salt concentration. Strains P273 and P812 were able to grow faster and to a higher cell density with betaine or proline in medium containing 3 or 4% salt. Salt tolerance varies among dairy propionibacteria and the

presence of proline or betaine in the medium can dramatically improve the salt tolerance of some strains. During cheese ripening, proteolytic breakdown of caseins, which have high proline contents, may contribute to osmoprotection of some *Propionibacterium* strains.

Key Words: *Propionibacterium*, salt tolerance, osmoprotectant

ASAS/ADSA Milk Synthesis

1281 Feeding dairy cattle to increase the content of conjugated linoleic acid in milk. Ying Huang, Barry Bradford*, Nicholas Heig, Jerry Young, and Donald Beitz, Iowa State University.

To evaluate effectiveness of conjugated linoleic acid (CLA) as the free acid and as the calcium salt to increase CLA in milk fat, 36 Holstein cows were fed six diets in a completely randomized block design with a 4-wk period for each replication. The control diet consisted of corn silage, alfalfa hay, and concentrates, and supplements were 1) 5% soy oil, 2) 1% CLA as free acid, 3) 1% CLA as the calcium salt, 4) 4% soy oil plus 1% CLA as the free acid, or 5) 4% soy oil plus 1% CLA as the calcium salt (Ca(CLA)2). No significant effects of dietary supplementation were found on daily milk yield, milk protein concentration and production, or milk lactose concentration and production. Supplementation of soy oil, CLA, or Ca(CLA)2 decreased milk fat concentration and production but had no effects on rumen VFA concentrations. Milk CLA was increased from 0.4% to 0.7% with 1% dietary CLA and to 1.3% with 1% dietary CLA plus soy oil. Dietary Ca(CLA)2 increased CLA milk fat to 0.9%; feeding Ca(CLA)2 with soy oil increased CLA in milk fat to 1.4%. Soy oil supplementation alone increased CLA content to 1.2%. In summary, dietary soy oil (5%) was as effective in increasing milk CLA as feeding dietary CLA (1%) or (Ca(CLA)2) (1%) with or without 4% soy oil. Dietary (Ca(CLA)2) resulted in greater concentrations of CLA in milk than did dietary CLA as free acids.

Key Words: Dairy Cows, Conjugated Linoleic Acid, Milk Fat

1282 Dietary fish oil plus vegetable oil maximizes trans-18:1 and ruminic acids in milk fat. D.L. Palmquist*¹ and J.M. Grinari², ¹OARDC/The Ohio State University, Wooster, Ohio, ²University of Helsinki, Finland.

Four Holstein cows were fed 4 diets in a 4 x 4 latin square design with 3-week periods. Diets were 60% haylage/40% corn-soy base concentrate (DM) with 3% added oil, consisting of 0, 33, 67 or 100% fish oil, with the balance made up with sunflower oil. Cows were fed for ad libitum intake; rumen contents were taken at 2 and 6 hours postfeeding, and milk was sampled on the last day of each period. Dry matter intake, milk yield and milk fat percentage were not different ($P > 0.05$) among treatments, nor were ruminal pH and concentrations and proportions of VFA at 2 and 6 hours postfeeding. However, there was a tendency ($P = 0.09$) for fish oil to increase molar proportion of butyrate at 2 hours postfeeding. All saturated milk fatty acids (4-16), 16:1, 20:4 n-6, and 20:5 n-3 were lowest with no fish oil, whereas fish oil decreased stearic, oleic and linoleic acids; linear regressions of percentage fatty acid on proportion of fish oil were significant. Quadratic effects of fish oil were significant for trans 18:1 ($P < 0.10$) and ruminic ($P < 0.01$) acids; treatment means (+/- SD) for 0 to 3% fish oil, respectively, were for trans 18:1: 14.2 (7.5), 18.1 (3.6), 18.6 (6.1), 13.7 (4.4)%, and for ruminic acid: 4.0 (1.2), 6.1 (1.7), 5.8 (2.1), and 3.4 (1.2)% of total milk fatty acids. Fish oil fatty acids may influence ruminal metabolism to maximize conversion of linoleic acid provided by sunflower oil to vaccenic acid. This approach increases milk fat ruminic acid up to ten-fold.

Key Words: Milk Fat, Vaccenic Acid, CLA

1283 Effect of dietary conjugated linoleic acids on the yield and composition of cow's milk. K.N. Simard*¹, P. Lacasse², L. Delbecchi², and P.Y. Chouinard¹, ¹Universite Laval, QC, Canada, ²Agriculture and Agri-Food Canada.

Conjugated linoleic acid (CLA) is an octadecadienoic fatty acid (FA) which has several effects on lipid metabolism. Previous work (Chouinard et al., 1999. J. Nutr. 129:1579) showed that abomasal infusion of CLA (CLA-60; Natural Lipids LTD, Hovdebygda, Norway) resulted in a significant reduction of milk fat synthesis. The objective of the present

study was to evaluate the effects of different forms of inclusion of dietary CLA (protected vs. unprotected) and the site of infusion in the gastrointestinal tract (rumen vs. abomasum) on milk fat synthesis in lactating dairy cows. Four multiparous Holstein cows in mid-lactation were utilized in a 4 x 4 Latin square design. Treatments were C) control (no CLA-60); R) addition of unprotected CLA-60 in the rumen; P) addition of protected CLA-60 in the rumen; and A) addition of unprotected CLA-60 in the abomasum. The CLA-60 mixture (unprotected and protected) contained 61% of CLA and was added (150 g/d) in the rumen or the abomasum three times daily (50 g at 0800, 1300, and 1800 h). At each period, treatments were administered for 7 days followed by 7 days of washout. Rumen protection of lipids was obtained by microencapsulation. Data from days 6 and 7 of the treatment periods were used for statistical analysis. Treatments had no effect on DMI and milk protein content. Milk yield was increased by protected CLA and averaged 23.7^{bc}, 24.7^{ab}, 26.8^a, and 21.7^c kg/d for C, R, P, and A, respectively ($P < 0.01$). Administration of CLA reduced milk fat content which averaged 3.94^a, 3.38^b, 2.94^c, and 1.86^d for C, R, P, and A, respectively ($P < 0.01$). Addition of CLA-60 in the abomasum increased CLA content of milk fat from 8.6^b (control) to 40.4^a mg/g FA. Milk CLA contents were not affected by R (11.8^b mg/g FA) or P (9.4^b mg/g FA). Feeding CLA-60 in unprotected form decreased milk fat content, but this decrease was of lower magnitude than that obtained with protected or abomasally infused CLA-60. Supported by Agribrands Purina Canada Inc.

Key Words: Dairy cows, Milk fat, CLA

1284 The effect of trans-10, cis-12 conjugated linoleic acid (CLA) infusion on milk fat synthesis and expression of lipogenic enzymes in the mammary gland of lactating cows. E. Matitashvili*¹, L.H. Baumgard¹, and D.E. Bauman¹, ¹Department of Animal Science, Cornell University.

Four cows in late lactation were used in a 2x2 crossover design, receiving either 0 or 14 g/d of trans-10, cis-12 CLA. Treatments were emulsified in skim milk and delivered by continuous abomasal unfusion (5 d) with a 14-d interval between treatments. Mammary gland biopsies were taken on d 5 of treatment. One portion was used for metabolic flux measurements and the other for Northern blot analysis. cDNA probes included: ovine acetyl-CoA carboxylase (ACC) and delta-9 desaturase (SCD), (both from M.T. Travers and M.C. Barber, Hannah Res. Inst., UK), ovine fatty acid synthase (FAS) (C. Leroux, LGBC-INRA, France), fatty acid binding protein (FABP) (purchased from ATCC), and bovine ESTs with sequence homology to glycerol phosphate acyltransferase (GPAT) and lipoprotein lipase (LPL) (both from J.C. Byatt, Monsanto Co.). The CLA treatment decreased milk fat percent and yield by 45% and 47%, respectively. Mammary explant incubations were designed to measure metabolic capacity and results indicated that CLA treatment reduced rates of acetate incorporation into fatty acids and oxidation to CO₂ by 82% and 61%, respectively. RNA analysis demonstrated that CLA treatment reduced abundance of all specific mRNA measured by 39 to 54%. Thus, treatment with trans-10, cis-12 CLA altered processes associated with *de novo* synthesis (ACC and FAS), uptake of preformed fatty acids (LPL), fatty acid transport and esterification (FABP, GPAT), and plasticity of milk fat (SCD). Furthermore, the magnitude of the reduction in message for these enzymes observed with CLA treatment was similar to that observed with *in vitro* rates of acetate utilization for fatty acid synthesis and oxidation to CO₂ and *in vivo* measurements of milk fat yield.

Key Words: Conjugated linoleic acid, Mammary, Lipogenesis

1285 In vitro lipid synthesis using bovine mammary homogenate. T. C. Wright*, J. P. Cant, and B. W. McBride, *University of Guelph*.

An in vitro system for lipid synthesis using bovine mammary homogenate was validated. Mammary tissue from Holstein cows producing 26.4 ± 3.5 kg/d (mean and standard error) of milk was isolated immediately after slaughter. Tissue samples were ground under liquid N to a fine powder and stored at -70°C until analysis. Tissue was homogenized in two volumes of isotonic sucrose in a Potter-Elvehjem tissue grinder and centrifuged at $15\,000 \times g$. Incubations were done at 37°C for 1h at pH 7.0 in a shaking water bath. The incubation solution (3.0ml) contained: 80 mM Tris-HCl, 0.80 mM MnCl_2 , 20 mM NaHCO_3 , 0.05 mM Coenzyme A, 1.7 mM ATP, 10 mM sodium citrate, 0.5 mM glucose 6-phosphate, 1.7 mM sodium acetate, 4.2 mM glutathione, 0.05 NADP, 20 mg/ml fatty acid free bovine serum albumin and 1 to 5 mg mammary protein. Incubations also contained approximately $1 \mu\text{Ci } 1\text{-}^{14}\text{C}$ sodium acetate. Exogenous fatty acids or synthetic detergent was bound to albumin before introduction to the incubation medium. Final exogenous concentrations ranged from 70 to $350 \mu\text{M}$. Lipid synthesis was linear with respect to protein content and time. Lipid products were extracted and an aliquot was counted in a scintillation counter. Supernatant protein concentration was estimated using the bicinchoninic acid method with bovine serum albumin as the standard. Results ($n=3$) indicated that when caprylic acid was incubated at a $350\text{-}\mu\text{M}$ concentration there was a 2.4% ($\pm 5.0\%$) increase in lipid synthesis compared to control incubations. At all concentrations from 70 to $350 \mu\text{M}$ exogenous palmitic acid decreased lipid synthesis (12 to 25% respectively). Albumin bound detergent did not decrease lipid synthesis. Results indicated that palmitic acid inhibits lipid synthesis in vitro and results are not a non-specific detergent effect.

Key Words: Lipid, In vitro, Mammary

1286 Kinetics of glucose transport by isolated bovine mammary epithelial cells. Changting Xiao*, John P. Cant, Michael I. Lindinger, and Brian W. McBride, *University of Guelph, Guelph, Ontario, Canada*.

Glucose is the sole precursor for lactose synthesis in lactating-cow mammary gland. The purpose of this research was to identify an appropriate description of glucose transport kinetics from extracellular fluid into lactating-cow mammary epithelial cells. Viable epithelial cells were isolated from lactating-cow mammary tissue by a collagenase dissociation technique. Cells were incubated with 3-O-methyl-D-[1- ^3H]glucose (3OMG) at 37°C , and initial rates of 3OMG entry were measured under four different experimental conditions: zero-*trans*, where extracellular [3OMG] were varied while intracellular [3OMG] was kept at zero; equilibrium-exchange, where intracellular and extracellular [3OMG] were the same and varied simultaneously; infinite-*cis*, where extracellular [3OMG] was saturating and intracellular [3OMG] varied; and infinite-*trans*, where extracellular [3OMG] varied and intracellular [3OMG] was saturating. Uptake of 3OMG by isolated mammary epithelial cells exhibited saturable kinetics and was inhibited by phloretin and HgCl_2 . The K_m and V_{max} for zero-*trans* entry and equilibrium-exchange measured in 3 cows were 6.95 ± 1.01 mM and 24.92 ± 3.41 nmol per min per mg cell protein, and 17.78 ± 1.74 mM and 39.77 ± 0.91 nmol per min per mg cell protein, respectively. The results demonstrated that both extracellular and intracellular concentrations of glucose need to be considered when simulating glucose transport by bovine mammary epithelial cells.

Key Words: cow, mammary epithelial cells, glucose transport

1287 Factors affecting lactose production of lactating rat mammary acini. K. H. Myung*¹ and S. R. Davis², ¹Chonnam National University, Kwangju, Korea, ²AgResearch, Rukura Research Centre, Hamilton, New Zealand.

In vitro performance of mammary acini from lactating rats was assessed by the measurement of lactose secreted into media during 24 h of culture using a highly sensitive bioluminescence assay. Lactose production was significantly higher in cells from fed relative to starved (18h) animals ($p<0.01$) and increased linearly with increasing glucose concentrations in the media ($p<0.0001$) over 0-6h culture period. Lactose production of cells prepared from fed rats maintained in media containing 30 mM

glucose was 8.9 fmol/cell/h over 0-6h of culture, but declined thereafter. Over 6-24h of culture period the highest lactose production was 3.6 fmol/cell/h of fed cells in 40 mM glucose concentration media and there was no significant difference in the productivity of cells prepared from rats starved for 18h. Prolactin, hydrocortisone or a combination of prolactin, hydrocortisone and insulin significantly ($p<0.0002$) decreased lactose production over both 0-6h and 6-24h culture periods. Insulin alone had no effect. No effects of shaking, Matrigel coating or cell density at seeding on lactose secretion were found. Aeration during tissue digestion significantly ($p<0.05$) increased lactose production over 0-6h culture period. In conclusion, lactose production by mammary acini in vitro approached in vivo rates for 6h of culture and was sensitive to nutritional state of donor animals and aeration during tissue digestion. Hormonal additions had a negative effect on cell performance.

Key Words: Lactose, Lactation, Cell culture

1288 The expression polymorphism of kappa-casein gene affects cheese yield. G Robitaille*¹, D Petitclerc¹, J Morisset², and M Britten³, ¹DSRDC, Agriculture and Agri-Food Canada, Lennoxville, Canada, ²Sherbrooke University, Sherbrooke, Canada, ³FRDC, Agriculture and Agri-Food Canada, St-Hyacinthe, Canada.

A differential allele-specific expression of kappa(κ)-casein gene was recently detected in Holstein cows genotyped κ -casein AB. Two different populations were defined: a group of cows presenting a similar level of expression for alleles A and B- specific κ -casein gene (cows HH) and a group of cows over-expressing the allele B-specific κ -casein gene compared to allele-A (group HL). The objective of this study was to evaluate the effect of this expression polymorphism on cheese yield to verify that an optimal expression of κ -casein gene effectively affects milk composition so that the cheese yield can be improved. Laboratory-scale cheddar-type cheeses were made from 144 ml of blended-milk samples at 7 test-days. At each test-day, milk samples from individual cows were pooled based allele-specific expression of κ -casein ($n=5$ for each group of cows), skimmed, dialyzed overnight at 4°C against bulk milk adjusted at pH 6.2 with lactic acid, and standardized for protein content. Cream was added so that protein to fat ratios were identical and close to 0.9 before cheese production. Data were analyzed by analysis of variance. The 37% (w/w) moisture-adjusted cheese yield from milk of cows HH was significantly higher ($P<0.005$) than the one obtained from milk of cows HL, 9.95 ± 0.03 % and 9.82 ± 0.03 % for cows HH and cows HL, respectively. The decrease in cheese yield observed for milk of cows HL was mainly due to protein lost in the whey. In conclusion, the 37% (w/w) moisture-adjusted cheese yield was higher when the κ -casein gene expression was improved. Funded by FCAR-NOVALAIT.

Key Words: kappa casein, gene expression, cheese yield

1289 Distribution of delta-9 desaturase mRNA in bovine tissues: effect of physiological state and diet. E. Matitashvili*¹, D.G. Peterson¹, D.H. Beermann¹, and D.E. Bauman¹, ¹Dept. of Animal Science, Cornell University.

Delta-9 desaturase introduces a cis-9 double bond in fatty acids and plays an important role in determining the plasticity of synthesized lipids and the endogenous synthesis of CLA. Tissue distribution of delta-9 desaturase (stearoyl-CoA desaturase, or SCD) mRNA was analyzed by Northern blot in Holstein cows ($n=9$) in different physiological states and in crossbred beef steers ($n=10$) fed different diets. Tissues included liver, mammary gland, subcutaneous and intermuscular adipose tissue, semitendinosus and longissimus dorsi muscle, heart, kidney, lung and brain. We have identified SCD mRNA as a 5 kb transcript using ovine SCD cDNA (M.T. Travers and M.C. Barber, Hannah Res. Inst., UK). Comparisons of cows in early and late lactation, and non-lactating, non-pregnant cows indicated highest expression of SCD mRNA in lactating mammary gland, and in adipose tissue independent of physiological state. Hepatic SCD expression in cows was low in all physiological states. Expression of SCD mRNA was about 30 times greater in lactating mammary gland than in the non-lactating state. Expression of SCD mRNA in liver and adipose tissue was greatest in non-lactating cows. Highest expression of SCD mRNA in steers was found in subcutaneous and intermuscular adipose tissue. Lower levels of SCD mRNA were found in kidney, lung and brain, but expression in liver was negligible. Steers ($n=5$) fed full-fat extruded soybeans at 25.6% of total dry matter intake for 111 days prior to slaughter exhibited markedly

elevated (2-3 times) levels of SCD mRNA in subcutaneous and intermuscular adipose tissue when compared to control steers (n=5) fed a corn-based diet. Overall, the greatest expression of SCD mRNA was observed in adipose tissue in steers and cows and in mammary gland in lactating cows and expression was regulated by physiological state and diet.

Key Words: Delta-9 desaturase, Expression, Tissue

1290 Milk fat globule size is not affected by diet restriction or soy oil supplementation. A.D. Beaulieu^{*1}, J.K. Drackley¹, J.M. Lynch², and D.M. Barbano², ¹University of Illinois, Urbana, ²Cornell University, Ithaca, NY.

Milk fat globule size and distribution influence the processing characteristics of milk fat. Abomasal infusion of high-oleic sunflower free fatty acids increased ($P < 0.001$) milk fat globule volume mean diameter (VMD) and decreased ($P < 0.001$) DMI (Overton et al., 1998, J. Dairy Sci. 81 (Suppl. 1): 352). An experiment was conducted to determine whether the increase in globule size was a result of the infusion or the DMI depression. Lactating Holstein cows (n=6) consumed a TMR ad libitum for 3 wk. During wk 4, 5, and 6, one-half of the group was restricted to 64%, 50%, and 37%, respectively, of ad libitum DMI. Milk production was decreased ($P < 0.05$) and milk fat percent was increased ($P < 0.05$) by 50% and 63% restriction. The proportions of C18:1_{cis-9}, C18:1_{trans}, and C18:2 in milk fat increased ($P < 0.05$) and proportions of C12:0, C14:0, and C16:0 decreased ($P < 0.05$) when cows consumed 50% or 37% of ad libitum intake. Neither the VMD nor the diameter below which 90% (d 0.9) or 50% (d 0.5) of the volume of milk fat is contained were affected ($P > 0.05$) by diet restriction. Milk fat globule size was positively correlated ($P < 0.05$) with C6:0 to C12:0 and C16:0 in milk fat and negatively correlated ($P < 0.05$) with C18 fatty acids. A second experiment examined the effect of soy oil supplementation on milk fat globule size. Six lactating Holstein cows were adapted to a basal TMR. Three cows then were fed the basal diet supplemented with soy oil (4% of DM) for 4 wk. Soy oil did not affect milk production or fat content ($P > 0.05$) but increased ($P < 0.05$) milk protein content. Soy oil did not affect ($P > 0.05$) milk fat particle VMD, d(0.9), or d(0.5) but decreased ($P < 0.05$) the contents of C4:0 to C16:0 and increased ($P < 0.05$) C18:1_{cis-9}, C18:1_{trans}, C18:2_{cis-9}, C18:2_{cis-12}, and C18:2_{cis-9, trans-11}, in milk fat. Although DMI restriction and soy oil supplementation affected milk fatty acid composition, milk fat globule size was unchanged.

Key Words: Milk fat globule size, milk fatty acids

1291 Supplementary infusion of amino acids and bovine somatotropin in atropine treated cows. P.H. Luimes^{*1}, J.P. Cant², X. Zhao¹, and D. Petitclerc³, ¹McGill University, St.Anne-de-Bellevue, Quebec, ²University of Guelph, Guelph, Ontario, ³Agriculture and Agri-Food Canada, Lennoxville, Quebec.

In cattle and sheep, muscarinic cholinergic antagonists, such as atropine, will decrease milk and milk protein yield. In cattle, blood concentrations of amino acids (AA) have been shown to decrease due to atropine, whereas, in sheep, muscarinic cholinergic antagonists have been shown to decrease serum somatotropin (ST) concentrations. Thus, atropine may provide an interesting model to determine the relative importance of endocrine and nutrient factors involved in milk synthesis. An experiment was conducted in which AA, bovine (b) ST or both were infused over 8h into cattle treated with atropine to determine whether one or both of these factors were responsible for the decline in milk protein production. Five mature Holstein cows were used in a 5 x 5 Latin square design, the treatments being: saline (0.9%), atropine (120 $\mu\text{g}\cdot\text{kg}(\text{MBW})^{-1}\cdot\text{h}^{-1}$), atropine + bST (850 $\mu\text{g}\cdot\text{h}^{-1}$), atropine + AA (25 $\text{g}\cdot\text{h}^{-1}$) and atropine + AA + bST. The AA profile of the infusate was designed to emulate the profile of milk protein. Atropine was unable to decrease plasma bST concentrations in lactating cows, though it did decrease plasma α -amino nitrogen (α -AN). Neither bST nor AA infusion were able to restore milk protein percent or milk protein yield. Perhaps other nutrient or endocrine factors, such as glucose, somatostatin, insulin and/or IGF-1 are involved in these effects of atropine infusion.

	Atr +		Atr +		Atr +		SEM
	Saline	Atr	bST	AA	bST + AA	SEM	
Milk							
yield (kg/8h)	9.8	7.4	8.0	7.6	8.5	0.7	
protein (%)	3.34a	3.13b	3.05bc	2.96c	2.98bc	0.18	
protein (g/8h)	341a	232b	243ab	227b	252ab	30	
Plasma							
bST (ng/ml)	2.40a	2.39a	6.71b	2.20a	6.14b	0.42	
α -AN (mM)	2.71a	1.90b	1.98b	2.81a	2.55a	0.13	

^{a,b,c}LSMeans are different within each row ($P < 0.05$).

Key Words: Atropine, Bovine Somatotropin, Amino Acid

1292 Correlations between specific binding of bST to desaturated hepatic membranes and various serum endocrine and nutrient components. M. Lonard¹, P.H. Luimes¹, E. Block¹, and D. Petitclerc^{*2}, ¹McGill University, St.Anne-de-Bellevue, Quebec, ²Agriculture and Agri-Food Canada, Lennoxville, Quebec.

Six mature Holstein cows were injected with 30.9 $\text{mg}\cdot\text{d}^{-1}$ of recombinant bovine somatotropin (rbST) from d 15 to 41 of lactation. Cows were assigned to one of two 3 x 3 Latin squares in which periods were of 6 d duration. Rests of 3 d were allocated to cows between periods. The experimental treatments, which began on day 18 of lactation, were saline (0.9%), glucose (50 $\text{g}\cdot\text{h}^{-1}$) and insulin + glucose (12.5 $\text{IU}\cdot\text{h}^{-1}$ + 50 $\text{g}\cdot\text{h}^{-1}$, respectively). Data concerning serum concentrations of endocrine and nutrient components were previously published (Léonard and Block, 1997; J.Dairy Sci. 80:127-143). Data regarding percent specific binding (¹²⁵I-bST.200 mg^{-1}) of hepatic membrane protein to bST were published by Léonard et al. (1992; J.Dairy Sci. 75(Suppl.1):182). Pearson correlation coefficients (r) were determined between specific binding of bST to desaturated hepatic membranes and serum insulin concentrations ($r = 0.82$, $P < 0.01$), serum IGF-1 concentrations ($r = 0.48$, $P < 0.05$), energy balance ($r = 0.47$, $P < 0.05$) and serum concentrations of NEFA ($r = -0.59$, $P < 0.01$). Serum glucose was not correlated with specific binding of bST to desaturated hepatic membranes. The mechanism by which insulin, which is usually at its nadir during early lactation, increases serum IGF-1 concentrations appears to be via an increase in specific binding of bST to its hepatic receptors.

Key Words: Specific Binding, Growth Hormone, Insulin

1293 Effect of 17-estradiol on milk production and mammary gland involution in Holstein cows in mid-late lactation. L. Delbecchi^{*}, D. Petitclerc, and P. Lacasse, AAFC-Dairy and Swine R&D Centre, Lennoxville, Quebec, Canada.

This study was conducted to assess the effects of estrogens on milk production and persistency of lactation in mid-late lactating cows. The hypothesis was that the increasing amounts of estrogens in the blood of pregnant lactating cows is one of the factors inducing or accelerating the progressive involution of the mammary gland observed during the declining phase of lactation. Eight non-pregnant Holstein cows, ranging from 177 to 338 d of lactation, received subcutaneous injections of either 17-estradiol (15 $\text{mg}/\text{cow}/\text{day}$; treated group, n=4) or excipient (95% ethanol; control group, n=4) from d 0 to d 8. Treated and control cows were paired according to the number of parities and milk yield. Milk production was measured from d -10 to d 20. Milk composition was evaluated on samples harvested before, during and after estradiol injection. One treated cow presented signs of acute mastitis on d 4 and was removed from the experiment. Milk production was reduced ($P < 0.01$) in treated versus control cows by 14.8% on d 3, 37.2% on d 6, 76.5% on d 8, and 81.6% on d 11. Two treated cows dried-off spontaneously by d 8 and d 9, respectively. Changes in milk composition characteristic of a mammary gland in involution were observed in treated cows. Between d 0 and d 7, milk fat content and lactose concentration decreased ($P < 0.05$) by 37.6% and 15.9%, respectively. During the same interval, milk protein concentration increased by 61.9% ($P < 0.05$). Control cows showed no significant variation in these parameters during the same period. Effects of estradiol at the molecular level are currently investigated. These results support the hypothesis that estrogens produced by the foeto-placental unit induce a gradual decline in milk production in pregnant lactating cows. This work was supported by Dairy Farmers of Ontario and Agriculture and Agri-food Canada.

Key Words: Involution, Mammary gland, Estrogens

1294 Transgenic Sows Overexpressing Alpha-lactalbumin: Piglet Growth and Milk Component Intake Early in Lactation. M.S. Noble*, M.B. Wheeler, and W.L. Hurley, *University of Illinois, Urbana, IL.*

Piglets reared by transgenic sows overexpressing α -lactalbumin (α -LA) grow at a significantly faster rate compared to piglets reared by control sows. Differences in piglet weight gain occur ($P < 0.05$) by d 6 of lactation and continue throughout the lactation period. By weaning (d 21 of lactation), transgenic reared piglets are 13% heavier than piglets reared by control sows. The objective of this study is to determine if increased preweaning growth by transgenic reared piglets is associated with altered milk component composition and component intake. Milk samples were collected from first parity α -LA transgenic sows ($n = 11$) and their non-transgenic littermates ($n = 13$) on d 3, 6, 9, and 12 of lactation. Milk samples were analyzed for concentrations of bovine α -LA, lactose, total protein, and total solids. Lactose, total protein, and total solids intake by transgenic reared and control reared piglets were determined from milk production data previously reported. Bovine α -LA was expressed throughout the lactation period (approximate mean concentration = 400 g/ml). Lactose concentrations were greater ($P < 0.05$) on d 3 and 6 of lactation, but not different on d 9 or 12 of lactation in milk of transgenic sows when compared with milk from control sows. Total protein and total solids concentrations in the milk of transgenic sows and control sows were not significantly different on d 3, 6, or 12 of lactation. Lactose and total solids intake were greater ($P < 0.05$) on d 3 and 6 of lactation for transgenic reared piglets compared to control reared piglets. Total protein intake was greater on d 3, 6, and 9 of lactation for transgenic reared piglets compared to control reared piglets. These data suggest that the elevated levels of lactose, total protein, and total solids intake by transgenic reared piglets early in lactation may account for the significant increase in their rate of preweaning growth.

Key Words: alpha-lactalbumin, transgenic sow, piglet growth

1295 A redefinition of the effects of mammary cell numbers and enzyme activities on predictions of milk yield and composition by a lactating dairy cow model. M. D. Hanigan*, F. E. Standaert, and D. C. Weakley, *Purina Mills, Inc., St. Louis, MO.*

The model of Baldwin (1995) provides a method to predict milk yield and composition over time. This allows accommodation of time-dependent effects such as previous plane of nutrition. However, in evaluating the model, it was found to be inadequate with respect to predictions of milk fat and protein. It was determined that an updated representation of mammary cell numbers and cell enzyme activities was required to resolve the problem. The model of Dijkstra et al. (1997) was adopted for representation of each.

$$Mass_{Mammary} = \alpha BW_{DIM0} e^{(-\beta + \chi Trt) \times DIM}$$

$$Synthesis_i = Enz_{i,DIM} e^{(\alpha_i (1 - e^{\beta_i \times DIM}))}$$

$$Degradation_i = Enz_i e^{(-\delta \times DIM)}$$

where cell numbers were calculated from mass of protein and total enzyme activity for each component ($i =$ lactose, protein, or fat) was calculated as the product of cell numbers and enzyme per cell. The mammary mass equation was parameterized from the data of Gibb et al. (1992) (see table). After adoption of the protein equation as a predictor of cell numbers, mammary enzyme equations were parameterized using a small production data set assembled from past studies conducted at the Purina Mills, Inc. research unit. After fitting to the data, predictions of lactation curves for milk fat and protein were significantly improved with root mean square prediction errors for milk and milk component yields declining by approximately 2 fold suggesting that this alternative representation was justified.

	α	β	χ	$P \leq .05 Trt$
Udder Mass	.044(.0016) ^a	.0019(.0004)	.0006(.0002)	*
Udder Protein	.005(.0002)	.0015(.0004)	.0006(.0002)	
Udder Fat	.006(.0004)	.001(.0007)	.0009(.0004)	*

Parameter estimates (SE) for Eq. (1) when fitted to the udder composition data of Gibb et al. (1992). Treatments (Trt) were 3 dietary energy intakes. ^aAll α and β coefficients were significantly different from 0 excepting β for udder fat.

Key Words: Lactating Cow, Model, Mammary

1296 Amino peptidase gene expression in caprine mammary gland; A possible role in peptide-bound amino acid uptake. S.J. Majeesh*¹, M. Cohen¹, O. Gal-Garber¹, A. Shamay², and Z. Uni¹, ¹The Hebrew University of Jerusalem, ²Agricultural Research Organization, The Volcani Center.

This experiment was conducted to isolate gene that express the enzyme aminopeptidase N (APN) in mammary gland of lactating goats. APN are enzymes anchored to the cell membrane via an N-terminal hydrophobic sequence of 20 amino acids that span the membrane only once. APN are highly expressed at the brush border membrane of the small intestine and are responsible for peptides hydrolysis and protein digestion. The mammary gland of ruminants do not express gene for peptide transporter (Pept1), however indirect evidence for peptide uptake by the gland is apparent. We hypothesized that APN enzyme would be expressed in the mammary gland of lactating ruminants and it may play an important role in peptide-bound amino acids uptake in the mammary gland. The first step in investigation this hypothesis was to isolate the gene from the mammary tissue. Caprine mammary gland tissue was collected for RNA isolation and basal-membrane vesicles (BMV) preparation. Total RNA was isolated from the mammary tissue and the APN gene was detected by RT-PCR using specific primers chosen from conserved regions of APN genes which identified as 531 bp cDNA. This cDNA fragment showed 83% homology to human, rabbit and rat intestinal APN. This cDNA fragment was used as probe in northern blot analysis which revealed a transcript of approximately 4.0 kb. Western blot analysis detected a protein of 155 KDa in BMV prepared from the mammary tissue. APN kinetics measurements in BMV revealed a high affinity enzyme with $k_m = 57 \mu M$ and $V_{max} = 270 \text{ pmol. mg prot}^{-1} \cdot \text{min}^{-1}$.

Key Words: Mammary gland, Amino peptidase, Peptide uptake

1297 Analysis of the sources of variation in CLA production in dairy cows. J.A. Kelsey*, D.G. Peterson, and D.E. Bauman, *Cornell University, Ithaca, NY.*

Conjugated linoleic acid (CLA) has a wide variety of health benefits based on animal models. Ruminant derived foods are the major dietary source and this relates to incomplete biohydrogenation of fatty acids. Some CLA escapes complete biohydrogenation in the rumen, but the major source is endogenous synthesis via Δ^9 -desaturase from *trans*-11 C_{18:1}, another biohydrogenation intermediate. Thus, milk fat CLA can vary because of rumen outflow of CLA and *trans*-11 C_{18:1} or activity of Δ^9 -desaturase. Our objective was to examine individual consistency and sources of variation in milk fat CLA. Holstein cows were divided into 3 groups ($n=10/\text{treatment}$) for the 12 wk study. One group (low) was fed a traditional corn-based TMR, a second group (high) was fed extruded, full-fat soybeans to achieve higher milk fat CLA, and the third group (switch) alternated treatments at 3 wk intervals between low (periods 1 and 3) and high (periods 2 and 4) diets. Average CLA concentration in milk fat was relatively constant among individuals and groups over the 12 wk for low and high treatments. Milk fat CLA was 3-fold greater in the high treatment and there was a 2- to 3-fold range among individuals for both diets. The switch treatment was also relatively constant within dietary treatment, with CLA concentration varying as expected, according to diet. In milk fat synthesis, Δ^9 -desaturase has four primary substrates; C_{14:0}, C_{16:0}, C_{18:0}, and *trans*-11 C_{18:1}. The ratio of these substrates and their corresponding products serves as a proxy for Δ^9 -desaturase and all 4 ratio comparisons allowed for similar conclusions. We focused on the C_{14:1}/C_{14:0} ratio because the predominant source of these fatty acids is mammary synthesis. Regardless of diet, ratios of C_{14:1}/C_{14:0} were similar for treatment groups with a 2- to 3-fold range among individuals. Furthermore, individual cows displayed remarkable consistency in the hierarchy across periods for all treatments, including the switch treatment where the diet and supply of substrate for desaturation varied in successive periods.

Key Words: CLA, milk fat, desaturase

1298 Effect of postpartum changes in BCS on milk components. DilipKumar Garikipati*¹, Sarjan Rao Kapa¹, and Kailash M.M.², ¹College of Vety Science, Tirupati, ²College of Vety Science, Bangalore.

Body condition scoring system with 1 to 5 scale (Edmonson et al,1989) was used in 137 crossbred HF cows in early to mid lactation to evaluate the post partum losses in body fat reserves and its influence on milk components. The effect on dry matter intake (DMI) was linear and a reduction of DMI (kg/day) with the increase in BCS ranged from 10.78 to 13 Kg/day for BCS 4.5 to 2.5 DMI decreased by 1.3 Kg/day for an additional increase in one unit of condition score. This showed that the DMI of fatty cows was less than the thin cows. As the live weight (kg) of the animals increased the BCS also increased indicated increase, in body fat reserves. Mean daily and peak milk yield over the first 6 months of lactation in relation to BCS were linear and there was a increase of 4.1 Kg and 7.8 Kg of daily milk yield and mean peak milk yield, respectively for every increase of one unit of condition score. Milk fat yield ranged from 3.1 to 3.9 percent and there was a positive response of 5 g/kg with an increase of one unit of condition score over the range 3 to 4 BCS. A positive milk protein output response was also observed with milk protein yield ranged from 32 to 34 g/kg with a meagre increase of 1g/kg over the range of 3 to 3.5 BCS and a decrease of 2g/kg for every one unit increase of BCS over the range of 3.5 to 4.5. The pattern of prediction equations for change in BCS to 120 DIM and 305 days FCM yield showed the BCS loss of 0.75 to 1.0 unit which was associated with more milk production. Higher rates of loss in BCS in second and third lactation numbers that have been associated with diminished milk production compared with its potential production. This suggested that increased feeding levels are warranted as the number of lactations advanced. Post partum decrease in BCS was observed upto three months and this was due to loss of body reserves through milk production which gradually recouped from fourth month onwards. This suggested that the increase in the post partum feeding levels will prevent the loss in BCS.

Key Words: BCS=Body Condition Score, fat, milk

1299 Evaluation of the antibacterial activities of lactoferrin derived peptides. P.-W. Chen, C.-L. Shyu, and F. C. Mao*, National Chung Hsing University, Taichung, Taiwan.

The hydrophobic and basic regions of N-terminal of lactoferrin, which contained 10 amino acids, originated from bovine (bLF20-29), caprine (cLF20-29), porcine(pLF20-29), human (hLF21-30) and murine (mLF20-29) were chemically synthesized. The minimal inhibition concentration (MIC) and minimal bactericidal concentration (MBC) against Gram-positive bacteria (*S. aureus* ATCC 25923 and *E. faecalis* ATCC 29212) and Gram-negative bacteria (*E. coli* ATCC 25922 and five wild strains of *E. coli* that resisted to broad spectra of antibiotics) were determined. The MIC and MBC of bovine lactoferrin and pepsin-digested bovine lactoferrin hydrolysates against selected bacteria were also determined and compared with that of synthesized peptides. The bLF20-29 had potent antibacterial activity that it inhibited and killed all the selected bacteria. The MIC for bLF20-29 was 30 µg/ml and the MBC was 60 µg/ml in selected *E. coli*. However, the peptides of cLF20-29, pLF20-29, hLF21-30 and mLF20-29 had less antibacterial activity. The MIC for these peptides were more than 500 µg/ml among the selected bacteria. According to the hydrophobic and basic pattern, two peptides modified from the bLF20-29 and cLF20-29 origin were synthesized, named LFM1 (Arg Arg Trp Trp Trp Arg Trp Arg Arg Trp) and LFM2 (Arg Arg Trp Trp Arg Arg Trp Arg Arg Trp). Both the LFM1 and LFM2 had excellent antibacterial activities. The MIC and MBC for these two peptides were similar in selected bacteria. The MIC and MBC were 2.8 µg/ml and 3.75 µg/ml in selected *E. coli*. The antibacterial activities of LFM1 and LFM2 were much better than the bLF20-29. The potent

antibacterial property of these peptides could be useful in further study and field application.

Key Words: lactoferrin, lactoferricin, antibacterial peptide

1300 Local expression of IGF-1 and IGFBP-3 mRNA in mammary tissue of prepubertal heifers after treatment with growth hormone. P.M. Jobst*¹, S.D. Berry¹, M.L. McGilliard¹, D. Ayares², D.A. Henderson¹, W.E. Beal¹, and R.M. Akers¹, ¹Virginia Polytechnic Institute and State University, ²PPL Therapeutics Inc.

Two experiments were conducted to determine the effects of bovine growth hormone (GH) and estradiol (E₂) on mRNA expression of insulin-like growth factor-1 (IGF-1) and IGF-binding protein-3 (IGFBP-3) in mammary tissue of prepubertal heifers. In experiment one seven heifers treated were with GH for 7d. Mammary parenchyma and stroma were collected by surgical biopsy before and after GH. Explants of parenchyma and stroma were cultured for 36h in media without or with GH (1µg/ml), E₂ (20pg/ml), GH + E₂, or IGF-1 (100ng/ml). RIA indicated serum IGF-1 and GH levels were elevated following GH treatment. Expression of IGF-1 and IGFBP-3 mRNA was not affected by GH treatment or hormones in culture. However, expression of IGF-1 mRNA was greater in stromal than parenchymal tissue. In experiment two, nine prepubertal heifers were administered placebo or GH. GH (Posilac[®]) was given every 14 days for three months. Blood samples were collected weekly. Heifers were sacrificed and mammary tissue collected. Stroma and parenchyma explants were cultured and analyzed for expression of mRNA as described above. Serum IGF-1 and GH levels were elevated following Posilac[®] treatment. Prior treatment of heifers with Posilac[®] did not affect the response of tissue explants in culture. However, in both parenchymal and stromal explants, IGF-1 increased (24%) expression of IGFBP-3 compared with explants in the absence of hormones. Stroma produced 27% more IGFBP-3 mRNA than parenchyma. Stroma explants cultured in E₂ or E₂ + GH produced 60% and 54% more IGF-1 mRNA respectively, compared to explants without hormones. Overall stromal explants produced 2.4-fold more IGF-1 mRNA than parenchyma explants. These data indicate that E₂ and IGF-1 elicit acute changes in the local IGF-1 axis of the bovine mammary gland.

Key Words: IGF-1, Growth hormone, Mammary gland

1301 Milk yield and constituents of Fleckvieh cattle in Bavaria:1-First lactation. Kamal Marzouk*[#], [#]Minia Univ..

Data from 3814 first lactation of Fleckvieh cattle was collected from 29 herds. This data came from milk recording organization in Bavaria, Germany. The aim of this study was to evaluate the milk yield and constituents of first lactation to erect a selection programme. The means of kg milk, 100-days for different traits of milk production and constituents were 1823.68 kg,72.40 kg,3.96%, 57.9 kg, 3.20%, 1.24%,0.75% and 2.14 MJ for milk yield, kg fat,%F,kg protein,%protein, Fat/Protein (F/P)ratio, index fP=(% fat-%protein)and energy in milk[milk energy yield (MJ)=milk yield* (0.37 * %fat+0.21* %P + 0.95)+milk yield * 0.07]], resp. The same traits at kg-milk, 200-days were 3395.42 kg, 134.14 kg, 3.95%, 111.01 kg,3.27%, 1.30%,0.67% and 2.16 MJ, resp. Also, at kg milk, 305-days the previous traits were 4553.44 kg, 183.50 kg, 4.07%, 152.4 kg, 3.32%, 1.68%, 0.76% and 2.21 MJ,resp. Effect of herd-years was significant on all milk yield and constituents traits at different periods except on fat/protein ratio at kg milk, 200-days. Seasons at calving had a significant effect on all traits at kg milk, 100-days except index fp,% fat, index fp at kg milk; 200 days and %fat, f/p ratio, index fp and energy in milk at kg milk, 305-days. On the other hand,the means of persistency=[(milk yield days 101-200/milk yield days 1-100)*100] was 82% and not affected by seasons of calving.

Key Words: Milk yield and constituents, Milk energy, Persistency

ASAS/ADSA Extension Education and ASAS/ADSA Teaching Undergraduate and Graduate Education

1302 Dairy farm HACCP: PMO bulk tank temperature and wash cycle compliance on 10 Minnesota dairies. S. Nagel and J. K. Reneau*, University of Minnesota, St. Paul, MN, USA.

Bulk tank temperatures should be a critical control point in a dairy farm HACCP plan. This study used temperature recording data loggers to

observe bulk tank temperature patterns on 12 Minnesota dairies. From a list of potential cooperators supplied by the Minnesota Department of Agriculture, 12 dairies were selected by geographical distribution and herd size. Onset Computers' HOB0[®] temperature recording data loggers were placed inside bulk tanks near the outlet. The thermometers

were programmed to record temperature every 10 min for 24 hr/d ranging from 2-14 mo. On one farm, the data logger failed and the data was irretrievable; on another, the electronic data was inadvertently lost. Electronic data was downloaded monthly and imported into a spreadsheet where descriptive statistical calculations and graphic presentations of data were accomplished. A total of 333,537 individual bulk tank temperatures were recorded at 10-min intervals in 11 bulk tanks on 10 of the farms. Preliminary analysis of a data subset indicated that maintaining commingled raw milk temperatures <50°F at subsequent milkings was a common problem. Farm 9 had a cooling failure. The tank's digital thermometer read 40°F but the tank was cooling milk at 50°F. During summer 1998, the tank on Farm 3 routinely recorded commingled milk at temperatures >50°F. With the exception of Farms 3, 5 and 9, all other bulk tanks appeared to meet PMO requirements to cool raw milk to <45°F within 2 hr after end of milking. In general, cooling milk to 45°F by 2 hr after end of milking did not seem to be a problem except on Farm 9 where the bulk tank was not functioning properly. Data loggers also recorded wash cycles. An average of 97% of the time, bulk tanks were sanitized after each milk pickup. Since herds were not randomly selected, it cannot be assumed that observations in these case studies accurately reflect bulk tank function or wash cycle compliance of the Minnesota dairy industry in general. As a pilot program, these findings support the need for further study. Monitoring bulk tank temperatures should be part of a dairy farm HACCP plan.

Key Words: HACCP, bulk tank, temperature

1303 Environmental mastitis pathogens in fresh bedding material. V. Eckes, M.A. LaValle, R.F. Bey, R.J. Farnsworth, and J.K. Reneau*, *University of Minnesota, St. Paul, MN, USA.*

Bedding type and particle size influence bacterial growth. Bedding samples were separated into three different particle sizes using a No. 8 and No. 18 mesh screen. Fifty ml of each particle size and 50 ml of the original unseparated bedding were each transferred into separate plastic Whirl-pak® bags and labeled. 100 ml of sterile distilled water was added to each Whirl-pak® bag and carefully mixed with the bedding. The mixture was then allowed to settle for 20-30 min. The supernate was pipetted (0.2 ml) from the Whirl-pak® bag and spread onto both CNA and MacConkey plates. Where necessary, serial ten-fold dilutions were prepared before plating the supernate on culture media. Bedding materials were incubated at 37°C and sampled at 0, 24, 48, and 72 hr. All plates were incubated 24 hr at 37°C. Bacterial counts were made to determine number of colony-forming units per cubic centimeter in the bedding materials. Bacteria were identified using biochemical reactions. Results indicate that all bedding materials supported growth of environmental pathogens. The degree to which growth occurred varied with the bedding material type and particle size. Large particulate bedding materials supported the least amount of growth while fine materials supported the greatest amount of bacterial growth. Ground sunflower hulls and chopped straw best supported growth, while pine wood shavings supported the least amount of growth. From these studies, it appears that ground sunflower hulls, hardwood shavings, straw, and fine material of any type are least desirable. The best bedding materials were sand and large pine shavings. Examples of intermediate bedding materials were paper dots, aspen, and a mixture of hard (oak) and soft (pine) wood. Particle size is a critical determinant in the ability of bedding material to support bacterial growth. When selecting bedding material, the type of bedding material and particle size must be carefully considered.

Key Words: bedding, mastitis pathogens, particle size

1304 Phosphorus adsorption implications on phosphorus management on dairies. T Downing* and J Hart, *Oregon State University.*

Management of phosphorus application and accumulation on dairies is a challenge in most established dairy regions in the US. In many areas, continual manure application has increased soil P above amounts sufficient for optimum crop yields leading to increased P loading to surface water, both in solution and attached to soil particles. The dairy industry has traditionally used soil testing to monitor P accumulations and crop needs. A significant dairy industry existed along the Oregon coast for over 100 years. For approximately the last 25 years, most dairies have over applied phosphorus from an agronomic standpoint. Soil test

P concentrations as determined by Bray P1 test indicate many dairy soils are deficient in available phosphorus. This observation has led many dairymen to purchase large quantities of commercial phosphorus fertilizer, even though most are over applying P with their manure applications. In addition, plant tissue phosphorus values and yield data indicate no shortage of phosphorus. The apparent contradiction among P application rates, soil test value and tissue P concentration caused us to evaluate the phosphorus adsorption capabilities of six major soil types on dairies along the coast. Soils were analyzed using the Bray P1 and phosphorus sorption isotherms were constructed by adding one gram of soil to increasing quantities of P ranging from 1 to 1000 mg/l. All assays were performed in triplicate. Bray P1 soil test values ranged from 8 to 83 ppm and averaged 29 ± 11.3 . Solution P values ranged from .07 to .51 mg/l and averaged $.31 \text{ mg/l} \pm .27 \text{ mg/l}$. Phosphorus adsorption characteristics were significantly different between soil types as determined by regression. These results indicate coastal soils in Oregon will respond differently to similar levels of phosphorus loading. These data also indicate that these soils have high absorption capabilities, compared to other results reported nationally. This study has increased our understanding of phosphorus management, but has also increased our interest in desorption possibilities.

Key Words: phosphorus adsorption, sorption isotherms

1305 Evaluation of dairy farmers' use of financial long-range planning. G. W. Robb*, S. B. Nott, and B. A. Dartt, *Michigan State University.*

The objectives of this study were to assess the farmer's use of financial long-range budgeting software output, and identify input factors that could improve accuracy of future projections. Twenty-nine Michigan and nine Minnesota dairy farmers, who had previously completed a Finlrb, Financial Long Range Planning, program within Finpack, University of Minnesota, were personally interviewed. Electronic files containing their projected budgets, as well as actual values invested in completed expansions were collected and compared. Overall usefulness of the program was rated very or extremely useful by 84% of the farms and 100% would recommend its use to their neighbors. The quality of technical assistance from the ten Extension personnel conducting the Finlrb was reported as very or extremely good by 95% of the farms. If charged for the Finlrb projection farmers would have paid an average of \$750. Thirty-one of the 38 farms completed investments at the time of the survey. They reported actual investments totaling \$12,802,161 for a median of \$284,550 per farm. The Finlrb projections of added capital totaled \$10,567,634. As a group the farms spent 21% more \$2,234,527 in their projects than investment numbers used in the Finlrb projection. Excavating, concrete, farm building labor, cattle prices and replacement animal costs were often under estimated. Many other differences between projected and actual investments were due to changes between time of the projection and project completion. Fourteen farms had Finpack's Year End Financial Analysis (Finan) completed for the year following construction completion. Net farm income achieved in the Finan was lower than the Finlrb projection on 71% of the farms while actual milk price received was higher than projected on 85% of farms. Four farms had a negative net farm income. Cow numbers and milk production per cow goals were met on 65% and 70% of the farms respectively. Actual feed and hired labor costs increased on 58% and 75% of the farms respectively. Finlrb was considered a useful decision-making tool. The analyzed Finans showed farmers were more successful in achieving herd size and production per cow goals than limiting feed and hired labor costs.

Key Words: Dairy, Extension, Financial planning

1306 A training workshop for the National Dairy InfoBase. M. A. Varner*¹, ¹*University of Maryland.*

The National Dairy InfoBase (NDIB Ver. 4) has been published on CD-ROM and the Internet by the not-for-profit Agricultural Databases for Decision Support organization (www.adds.org). Use of the NDIB can be accentuated by providing training on the program's use. A hands-on training program was planned for dairy producers and advisors as a pre-conference workshop for the Maryland Dairy Industry Association. The workshop was held in a networked computer lab at a local community college. Registration was limited by ten computers. Two people per computer were allowed, and twelve individuals participated. After completion of the workshop, the goal was for the participants to

be able to: 1) install the ADDS National Dairy InfoBase (NDIB, Ver. 4) from the CD to the hard disk of their computer; 2) start the NDIB on their computer; navigate the various windows within Folio Views; 3) browse through publications in the various subjects; 4) Search the NDIB with single word, multiple word and phrase searches; 5) print various amounts of a publication and 6) use the NDIB over the Internet. The workshop was held in a two hour time period. Introductory remarks were made before each of the six sections and then individuals were encouraged to complete the step-by-step tutorials that would allow them to accomplish the desired tasks when returning home with their CD-ROM disk. After approximately 15 minutes, a short summary was presented and an introduction was made for the next topic. The workshop was presented by one instructor and the time between presentations was spent answering individual questions. All participants were able to complete the workshop in the two hour time frame. Conducting the hands-on workshop for the NDIB as a pre-conference program was desirable as participants could maximize their educational efforts on that day. A copy of the training materials used in the workshop are available at <http://www.wam.umd.edu/markv/NDIB.pdf>.

Key Words: Dairy, Computer, Training

1307 Teaching pork producers breeding and gestation herd management skills via the Internet. M.T. See* and B.A. Belstra, *North Carolina State University, Raleigh NC.*

To enable distance education for pork producers and their employees a nationally developed curriculum was transformed into an Internet course comprised of interactive HTML lessons, images, and self-grading quizzes. The Breeding and Gestation Herd Management Curriculum is divided into six sections. These sections are not separated to be equal in length but rather to break at distinct phases of breeding and gestation management. The Internet course was pilot tested in cooperation with the National Pork Producers Council during the spring of 2000. In the pilot class 39 participants enrolled and 26 completed the course. Participants were from 17 states (AK, AR, CA, FL, GA, IA, ID, IN, IL, MI, MN, MO, NC, NE, NH, OH, OK), Ecuador, Colombia and the Philippines. Of the 26 participants completing the course 14 were owner/operators, 6 were farm managers, 2 were breeding and gestation managers, 3 were employees and 1 was an educator. Of the 26 completing the course 20 were male and 6 were female. After completion of the six lessons and quizzes students were asked to complete a survey response. Average time spent on this course was 12 hours per student and most students worked on the material in the evenings. The completion of the pilot Internet course resulted in an average quiz score of 88.2%. Ninety-six percent of the participants completing the course agreed that Breeding and Gestation Herd Management provided him or her with an opportunity to improve their job skills. When asked about their improvement of knowledge on 14 key concepts the average responses ranged from 2.0

to 2.5 for every concept where 1 is Strongly Agree and 5 is Strongly Disagree. Furthermore 46% of the completing students indicated that they planned to make changes in their breeding and gestation barn practices based on information they learned in Breeding and Gestation Herd Management. Ninety-six percent of respondents also indicated that they would be interested in taking additional courses over the Internet. These results demonstrate that distance education programs not only makes information readily available at a time convenient to the clientele but that it is also effective in delivery and can result in improved knowledge and job skills.

Key Words: Pigs, Internet, Breeding

1308 Undergraduate education: exposing first- and second-year students to laboratory research. G. F. Erf*, W. G. Bottje, H. D. Chapman, M. Iqbal, R. Okimoto, and M. S. Parcels, *University of Arkansas, Fayetteville, AR, USA.*

In agricultural colleges with a strong research base, there are many research opportunities for undergraduate students in formal and informal settings (e.g., special problems courses, internships, work study and honors programs, etc.). However, entry-level undergraduate students interested in research opportunities may not pursue these interests due, in part, to limited exposure to the research environment, a lack of confidence, and difficulties in identifying a research mentor. The laboratory course entitled Rotations in Agricultural Laboratory Research described below was developed to provide first- and second-year undergraduates interested in science-based agricultural programs with the opportunity to conduct hands-on, interdisciplinary, team-based research. During the first 8 wk, students were taught research techniques and approaches during a 4-h structured laboratory and a 1-h discussion-session per wk. The teachers involved were researchers from three disciplines. For example, during Year 1, nine students conducted laboratory exercises in parasitology, immunology, and molecular virology. During wk 9, the students split into two groups and, with the aid of their teachers, each group developed a 4-wk research project integrating techniques used from at least two of the three disciplines. The teachers served as mentors for projects involving their discipline throughout the project period. The students reported their project and final results in an oral presentation and a written abstract. Students were evaluated based on the quality of their laboratory notebook, weekly quizzes on concepts learned in the laboratory, and their final abstract and presentation. Although still at the experimental stage, this course was very successful in providing students with confidence, enthusiasm, and the contacts to successfully pursue laboratory research opportunities. Currently (Year 2), disciplines taught are cellular physiology, immunology, and molecular genetics.

Key Words: Education, Laboratory course, Experiential learning

ASAS/ADSA International Animal Agriculture

1309 Interaction between chopping length of corn silage and long hay on chewing activity of dry cows. Paolo Berzaghi*^{1,2}, Giulio Cozzi¹, Flaviana Gottardo¹, and Iginio Andrighetto¹, ¹University of Padova, Italy, ²US Dairy Forage Research Center, Madison, WI.

Five Holstein dry cows were used in a 5 x 5 Latin square design with periods of 14d. Diets consisted of corn silage chopped at 6.7mm (S) and 14mm (L), long grass hay (H), and a combination of hay (20 %DM of the forages) with the short (SH) and the long (LH) corn silage. In all of the diets, soybean meal and a mineral premix were mixed to the forages to obtain a TMR with a CP concentration of 10 % DM. Diets were fed ad libitum (10% refusals) once a day. Chewing activity was monitored during the last 5d of each period using a portable APEC device (INRA, Clermont Ferrand, France) connected to a foam filled balloon placed under the lower jaw of the cows. The greater NDF content of grass hay (71.1 %DM) than the corn silages (44.6 %DM) reduced ($P < .01$) DM intake of H diet, but it maximized its NDF intake (7.0 vs. 5.6 kg; $P < .001$) in comparison to the four corn silage based diets. In diet S 2.6 % of the particles were retained by a 19mm screen. The coarser chopping of L diet increased this value up to 7.2 %. The different particles size did not affect DM intake and eating time, but it resulted in longer rumination time (491 vs. 389 min/d; $P < .02$) for L compared to S diet. The addition of hay to the corn silage diets resulted in a higher content (+3.7

%DM) and intake of dietary NDF (5.9 vs. 5.3 kg/d; $P < .02$). However, the rumination time of SH and LH diets was similar, leading to a significant ($P < .03$) hay addition x silage chopping length interaction. The same interaction tended to be significant ($P < .06$) for effective NDF, measured as time spent chewing per kg of NDF intake. The results indicate that chewing activity is affected by the particle size of the forage and by associative effects among forages with different composition and particle size. These results would also support the suggestion that in dry cows normal chewing activity is maintained by providing diets with 10-15 % of forage particles retained by a 19mm screen.

Key Words: corn silage, chopping length, chewing activity

1310 The peruvian dairy sector: farmers' perspectives, development strategies and policy options. Thomas Bernet¹ and Carlos Gomez*², ¹International Potato Center, Lima/Swiss Agency for Development and Cooperation, ²Universidad Nacional Agraria La Molina, Lima.

This work assesses how expected market changes, farm strategies, and policy interventions might affect typical milk producers within the main Peruvian milksheds: Arequipa (coast), Lima (coast) and Cajamarca

(highlands). The analysis is based primarily on the application of a flexible farm-household optimization model able to project farmer behavior in different farming systems under varied production conditions. Cross-regional analysis shows a certain distortion in the current market situation, driven by varying degree of competition among the main milksheds for regionally produced milk. In Lima, the elevated number of regional milk buyers, many with under-used processing capacities, have caused strong competition on the demand side, provoking high milk prices. In Arequipa and Cajamarca, prices are much lower, since there are fewer wholesale milk buyers and thus less competition for farmers milk supply. Because condensed products for the Lima market (evaporated milk and cheese) are produced most cheaply in Arequipa and Cajamarca with local milk supply, corresponding growth in milk demand is likely to increase milk prices in those milksheds. The effect is enhanced by the fact that imported milk powder is more expensive than regionally collected milk, thanks to Peru current import taxation scheme. In Lima, a drop in milk price will consolidate the prevalence of better managed, more efficient larger dairy farms, because small and medium farms lack economies of size and tend to become unprofitable. In Arequipa, despite the expected increase in milk prices, dairy production is expected to decline, as farmers will tend to shift stronger towards agricultural crops when the price risk decreases in crop production. In contrast, in Cajamarca, the expected increase in milk prices will provide an important incentive for farmers to identify dairy production with improved feed and herd management. Potential government interventions could also reinforce and accelerate the expected upturn of dairy production in highland areas.

Key Words: Milk Production, Peru, Dairy Development

1311 Macedonian Dairy Industry situation and outlook. Aleksandra Depinovska*¹ and Mingruo Guo², ¹*Land O'Lakes-Macedonia, Kej 13 Noemvri bb,1000 Skopje, Macedonia,* ²*University of Vermont, Burlington VT 05405.*

Macedonia is a small country situated in the heart of the Balkan Peninsula, approximately the same size as Vermont. The dairy industry of Macedonia has undergone a difficult process of transition since 1991. Dairy herds in Macedonia consist mainly of cows and sheep. The dairy cow population increased from 90,000 in 1991 to a peak of 93,000 in 1996 and decreased back to about 90,000 in 2000. The raw milk supply is primarily collected from thousands small farms with an average of 5-10 cows each. The average milk production per cow is still very low compared with the US standard. However, milk productivity has been improved through genetic breeding since 1991. The average annual yield was increased from 1,357 liters per cow in 1991 to 1,700 liters in 2000. Total cow's milk production was increased from 119,194 tons in 1991 to 148,445 tons in 2000. Sheep milk is the second important source of dairy production for the country. The share of sheep milk was about 25% of the total milk production in 2000. In contrast, the population of sheep has been decreasing since 1991 from nearly 1.5 million to about 1 million in 2000 due to the embargo on the export of Macedonian lamb imposed by the EU. Presently there are 49 registered dairy processing plants in Macedonia. The majority of them are small operations ranging from 5 to 10 tons of processing capacity, with except of the Bitola Dairy Plant which can process up to 200 tons of milk per day. Per capita milk consumption is more than 120 kg per year. The major domestic dairy products in Macedonia are cheese and fluid milk products including yogurt. Domestic products are only enough for 75% of the Macedonian market needs and the rest are imported from Europe, especially dry milks, butter, and nearly all the functional additives, including stabilizers, flavoring agents, starter cultures, and other nutritional additives. The dairy industry has a potential to grow. Challenges faced by Macedonian dairy industry include procuring high quality of raw milk from the small family farms, developing new and high quality dairy products, improving production efficiency, and developing a well-trained work force.

Key Words: Macedonia, Dairy Industry, Milk Products

1312 The suitability of the Beefmaster as a dam breed in hot and arid regions of Israel. J.E. Huston¹, Z. Holzer², P.V. Thompson*¹, Y. Aharoni², and B.S. Engdahl¹, ¹*Texas A&M University System, San Angelo, TX,* ²*Israeli Ministry of Agriculture, Haifa, Israel.*

A study supported jointly by the Texas Department of Agriculture and the Israeli Ministry of Agriculture was conducted to evaluate the adaptability of Texas Beefmaster cows to the environmental conditions of southern Israel. Beefmaster embryos were transferred from Texas donor cows into Israeli recipients, and the resulting offspring were raised under local conditions to 2 and 3 yr of age. These cows were compared to similar aged Simford cows (products of crossing European breeds, Simmental and Hereford) on a cooperating site in southern Israel over a 3-wk period during August 2000. Each animal was monitored for time spent lying, standing, walking and grazing over 24-h periods. Heart rates and body temperatures were monitored for 24-h cycles using data loggers, and energy expenditures were estimated by measuring oxygen consumption. Voluntary intake of forage was calculated for each cow from fecal output estimated using intraruminal chromic oxide boluses. Behavioral activities showed greater similarities than differences. Each group was active during the early morning hours, rested during the afternoon, and then resumed grazing during the early evening. Heart rates and skin temperatures for the Beefmaster cows were lower during the early morning hours, indicating a greater capacity to dissipate body heat during nighttime hours. The energy expenditure (kilo joules / (W^{0.75}*d)) varied greatly among individual cows. Fecal output and forage intake did not differ between breed groups. The Beefmaster cows produced from embryos transferred from Texas cattle appeared at least equally well adapted to Israeli conditions as cattle currently produced in the area. Subsequent studies measuring productivity (reproductive rate, growth rate and efficiency, and carcass value) are needed to determine whether the Beefmaster breed can improve productive and economic efficiencies of cattle herds in this region.

Key Words: Beef cattle, Adaptability, Israel

1313 Effect of seasons on milk production and calving pattern in nili ravi buffaloes . Syed Hassa Raza*¹, Arshad Iqbal¹, M.S. Khan¹, Shahid Mahboob², and M. Abdullah¹, ¹*Faculty of Aniaml Husbandry, University of Agriculture, Faisalabad, Pakistan,* ²*Dept. Zoology, Govt. College, Faisalabad, Pakistan.*

Although buffaloes are not seasonal breeder but they do show seasonality in breeding and calving which ultimately results in shortage of milk in summer, when its demand is at peak. To investigate the effect of different seasons on traits of economic importance in dairy buffaloes, this study is conducted. The data on five years (1983-1987) regarding calving, milk production and breeding in Nili Ravi buffaloes, maintained at the Livestock Experiment Station, University of Agriculture, Faisalabad were collected and statistically analyzed. It was inferred that seasons have significant (P<0.01) effect on calving pattern, milk production and occurrence of heat in dairy buffaloes. Maximum calving took place in autumn (45.29 %) and minimum in winter and spring (5.66 %) in each case. The highest values for milk production were observed in autumn (25,528 lit.) and lowest in summer (14,507 lit.). Out of the total, about 48% buffaloes exhibited heat in winter and only 2.39% in summer. These revealed that severe summer season adversely impair the reproductive efficiency of the lactating females. Through adoption of certain management practices, this effect of heat stress can be minimized to alleviate the situation for the improvement in milk supply.

Key Words: Buffalo, Milk, Environment

1314 Effect of high-levels of brewery supplementation on blood metabolites of Holstein cows from a semi-intensive dairy in north-central Mexico. E Guzman, RM Rincon, DF Cortes, R Baulos-Valenzuela*, and CF Archiga, ¹*Universidad Autonoma de Zacatecas. Zacatecas, Mexico..*

The purpose of this study was to determine blood- metabolite differences in response to a high-level of brewery supplementation, which has become a routine practice in typical semi-intensive dairies from north-central Mexico (Fresnillo, Zacatecas) with low level of technology and grain scarcity. Twenty-one lactating dairy cows were exposed to 3 different levels of brewery supplementation: 25, 50 and 75% of the

diet. Besides brewery, cows received corn silage, concentrate, and access to a rye-grass pasture during 4 h/d. Brewery supplementation at the 75% level increased blood pH ($P < 0.01$), reduced glucose ($P < 0.001$), and tended to increase protein ($P = 0.10$). Besides, there was a general correlation within glucose and protein, glucose and glutamic-oxaloacetic transaminase (GOT), pH and GOT, protein and GOT. In conclusion, high levels of brewery supplementation increase blood pH, tended to increase protein and reduce glucose in dairy cows.

Key Words: Dairy Cow, Blood Metabolites, Mexico

1315 Timed-embryo transfer (Gyr/Holstein) in recipient cows exposed to a synchronized ovulation. BA Barrios, LA Guillen, JC Acua, and CF Arechiga*, ¹Universidad Autonoma de Zacatecas, Zacatecas, Mexico.

The purpose of the present work was to evaluate heat induction and pregnancy rates in response to a frozen/thaw embryo transfer (Gyr/Holstein embryos) in the uterine horn ipsilateral to the corpus luteum of recipient cows exposed to a synchronized ovulation. Experiment was done from April to August. Twenty-six cows from different locations and genetic background were exposed to a synchronized-ovulation protocol (d 0, GnRH; d 7, PGF2a; d 9, GnRH; d 10, checking estrus instead of timed AI; d 17, embryo thawing and deposition). Cows were rectally palpated at each farm on d 10 of treatment and signs of estrus were observed. However, cows were not inseminated but rather and embryo was deposited in the uterine horn ipsilateral to the corpus luteum palpated at d 17. During embryo transfer cows were rectally examined, feces were removed, and perianal region was washed. Then the embryo was deposited using a Cassou AI gun passing through the cervix of the uterus and leading it into the uterine horn ipsilateral to the ovary that contains a corpus luteum. Sixty days after embryo transfer, cows were diagnosed for pregnancy and 19.2% of the recipient cows were pregnant (i.e., 5/26). One of the cows received two embryos and the cow delivered both calves alive. In conclusion, the synchronized-ovulation protocol could be utilized for synchronization of cows included in embryo transfer programs. However, in this preliminary study, pregnancy rates were low probably due to the heterogeneity of the cows included in the trial.

Key Words: Synchronized Ovulation, Embryo Transfer, Mexico

1316 Meat quality characteristics of loin eye and tenderloin muscles of native Korean (Hanwoo) steers. Y.K. Lee¹, K.H. Kim*¹, Y.S. Kim², S.S. Sun¹, and M.G. Baik¹, ¹Chonnam National University, Kwangju, Korea, ²University of Hawaii at Manoa, Honolulu.

The objective of this study was to investigate postmortem glycolysis, histochemical, and meat quality characteristics of longissimus dorsi (LD) and psoas major (PM) muscles of Hanwoo (native Korean) steers. Four steers weighing about 550 kg were slaughtered, then 20 g of LD at the 13th rib and PM at the 4th lumbar vertebra were collected at 1, 2, 6, 12, and 24 hr postmortem to measure changes in metabolite concentrations and pH. At 24 hr later, 1 cm³ of LD and PM samples were cut for histochemical analysis. At 1, 3, 7, 14, and 21 day postmortem, LD samples between 6th and 12th rib and PM were collected for TBA value and shear force measurements. Three 1.8 cm diameter cores were prepared for shear force measurement from 2.54 cm thick steaks that were

vacuum packaged and cooked in a water bath at 70°C. ATP and pH in PM declined faster ($p < 0.05$) than those in LD during the 24 hr post-mortem period, and remained lower at 24 hr after slaughter (0.47 vs 0.62 μ moles/g muscle, 5.92 vs 5.64). Glucose-6 phosphate in PM increased faster ($p < 0.05$) than in LD muscles, and remained higher (11.5 vs 5.5 μ moles/g muscle). LD had a lower ($p < 0.05$) proportion of type I fiber than PM (51.1% vs 58.3), but higher ($p < 0.05$) proportion of type IIB fiber than PM (18.9% vs 9.0%). The shear force to cut cooked PM was lower than that for LD in 1 and 7 day aged samples, but no difference was observed between the two muscles in 21 day aged samples. The TBA value increased gradually during the 21 day aging period in both muscles. The increase in TBA value was similar in both muscles up to 14 days, but at 21 day the TBA value of PM was significantly higher than that of LD. In summary, this study demonstrated that the rate of postmortem glycolysis is faster in the PM than in the LD. The study also indicated that PM muscle needs less aging time than LD muscle for optimum meat quality.

Key Words: Native Korean steer, Meat Quality, Postmortem metabolism

1317 Characterization of forage trees as strategic feed sources for goats under semiarid rangeland conditions of Tamaulipas, Mexico. R. Hernandez¹, A. Tewelde¹, S. S. Gonzalez*², E. Gutierrez³, H. Diaz⁴, and F. Briones¹, ¹U. Autonoma de Tamaulipas, ²Colegio de Posgraduados, ³U. Autonoma de Nuevo Leon, ⁴U. Autonoma Agraria Anotonio Narro.

Ten locally available forage trees under semiarid rangeland in the State of Tamaulipas were identified and characterized as main feed sources for goat based production systems that predominate in the area (22 C average temperatures; 500 mm average rainfall in August- December). The forage trees included Guajillo (Acacia berlandieri), Gabia (A. rigidula), Huizache (A. romeriana), Granjeno (Celtis spinosa), Pata de gallo (Chloris virgata), Cruceto (Condalia lycioides), Nacahua (Cordia boissieri), Vara dulce (Eysenhardtia polystachya), Escoba (Fraxinus greggii), and Charrasquillo (Pithecellobium elasticophyllum). Density was estimated by the Point Quarter Center method (Bruce, 1986) using the formula of Arvanitis and Portier (1997): $D = 1/x^2$, where D is plant density by m², and x is the average distance between each sampling. Results showed densities (%) of: A. berlandieri 29.99, C. virgata 29.91, C. boissieri 13.29, A. romeriana 7.47, A. rigidula 5.48, C. spinosa 4.06, F. greggii 3.32, E. polystachya 2.65, C. lycioides 2.25, P. elasticophyllum 1.53. Production (kg/ha) of biomass, wood and forage was higher for A. berlandieri (3871, 2879, 993, respectively) and lower for P. elasticophyllum (44, 39, 5, respectively). Proximal analysis and in vitro DM digestibility (IVDMD) values (%) ranged from 82 to 94, 11 to 21, 26 to 58, 16 to 38, 5 to 17, 11 to 46 for DM, CP, NDF, ADF, ashes and IVDMD, respectively. The CP (21%) and IVDMD (46%) values were higher for C. spinosa. Intake of plant parts by goats, measured by direct field observation showed: foliage in A. romeriana, C. virgata, A. berlandieri, A. rigidula, C. lycioides, E. polystachya, P. elasticophyllum; leaves in C. spinosa, F. greggii; fruits in C. boissieri, C. virgata; pods in A. berlandieri; stems in F. greggii. Six of the forage trees (A. romeriana, C. boissieri, C. spinosa, A. rigidula, A. berlandieri, C. lycioides) are used as fuel wood by local farmers.

Key Words: Forage Trees, Goats, Semiarid Rangelands

ASAS Nonruminant Nutrition: Specialty Grains and Amino Acids

1318 Soybean meal from Roundup Ready® or conventional soybeans in diets for growing-finishing pigs. G. L. Cromwell*¹, M. D. Lindemann¹, J. H. Randolph¹, E. P. Stanisiewski², and G. F. Hartnell², ¹University of Kentucky, Lexington, ²Monsanto Co., St. Louis, MO.

Dehulled soybean meal (SBM) prepared from genetically-modified, herbicide-tolerant soybeans containing the CP4 EPSPS protein (Roundup Ready® [RR]) and near-isogenic conventional (C) soybeans were assessed in an experiment with growing-finishing pigs. The soybeans were grown in yr 2000 under similar agronomic conditions, the RR soybeans were sprayed with Roundup®, and both were processed at the same plant. The C-SBM and RR-SBM were indistinguishable in composition (DM: 90.3, 91.0%; CP: 51.5, 51.2%; NDF: 4.95, 4.85%; ADF:

3.50, 3.94%; lysine: 3.16, 3.09%; meth+cys: 1.47, 1.51%). Crossbred pigs (n=100) were fed fortified corn-soy diets containing C- or RR-SBM from 24 to 111 kg BW. Diets contained 0.95% lysine initially, then lysine was reduced to 0.80 and 0.65% when pigs reached 54 and 87 kg BW. There were 10 pens (5 pens each of barrows and gilts)/treatment with 5 pigs/pen. All pigs were scanned at 104 kg mean BW, and all barrows were killed at the end of the test for carcass measurements and tissue collection. ADG (833 vs 854 g), ADFI (2.53 vs 2.64 kg), feed:gain (3.04 vs 3.09), scanned backfat (BF, 18.8 vs 19.1 mm) and longissimus area (LEA, 34.9 vs 33.8 cm²), and calculated carcass lean (52.9 vs 52.5%) were not different ($P > 0.05$) for pigs fed C- and RR-SBM. Gilts gained slower, but they were more efficient and leaner ($P < 0.05$) than barrows. Responses to type of SBM were similar for the two genders. Carcasses

were not different ($P > 0.05$) for barrows fed C- and RR-SBM (71.8 vs 71.2% dress, 26.8 vs 27.4 mm 10th rib BF, 37.8 vs 35.5 cm² LEA, 48.1 vs 47.3% fat-free lean). Longissimus samples from barrows fed C-SBM tended to have less fat than those fed RR-SBM (3.0 vs 3.4%; $P < 0.06$), but water, protein, and ash were similar (72.8 vs 72.5%; 23.4 vs 23.3%; 1.05 vs 1.05%). The CP4 EPSPS protein was not detected in loin tissues of any of the pigs fed RR-SBM. The results indicate that RR-SBM is essentially equivalent in composition and nutritional value to C-SBM for growing-finishing pigs.

Key Words: Pigs, Soybeans, Biotechnology

1319 Comparison of apparent ileal amino acid digestibility values of high oil (HOC), high oil/high oleic acid (HOHOC), and low phytate (LP) corn diets fed to finishing pigs. J. W. Frank*¹, G. L. Allee¹, and T. E. Sauber², ¹University of Missouri, Columbia, MO, ²Dupont Specialty Grains, Johnston, IA.

Two experiments were conducted to evaluate the apparent ileal amino acid digestibility values of multiple corn varieties. In both experiments pigs were surgically fitted with T-cannulas and allowed a minimum of 2 weeks to recover. All animals were fed twice daily (0600 and 1800 hr) at a rate of .09 × BW^{0.75} for a five day adjustment period, followed by two days of twelve-hourly collections. Pigs were allowed ad-libitum access to a nipple waterer. Samples were immediately frozen (-20 °C) as collected. At the end of both studies pooled samples from the two day collection were sub-sampled, freeze dried, ground, and analyzed for amino acid content along with the corn based diet. In experiment 1, six crossbred barrows (initial BW = 101.8 kg) were arranged as two 3 × 3 Latin squares and housed in 2.43 × 1.83 m pens at a temperature of approximately 23 °C. The three dietary treatments consisted of HOC, HOHOC, and a typical corn equivalent (TC). Tryptophan digestibility was greater in HOHOC (64.2%) compared to TC (54.2%), but not different than HOC (61.6%; $P < .10$). In contrast proline digestibility was greater in TC (74.3%) and HOC (71.9%) compared to HOHOC (64.7%; $P < .05$). There were no other differences in apparent amino acid digestibility. In experiment 2, five crossbred barrows (initial BW = 89.3 kg) were used in a crossover design and housed in stainless steel metabolism crates. The two dietary treatments were LP corn and a typical corn equivalent (TYP). Phosphorus digestibility was greatest in the LP corn compared to the TYP corn ($P < .01$). Tryptophan digestibility was also greater in LP corn compared to TYP corn (62.0 vs. 50.9%; $P < .05$). As in experiment 1, there were no other differences in amino acid digestibility. In conclusion most amino acid digestibility values were not different in the high oil, high oil/high oleic acid, and low phytate corn varieties compared to their typical corn equivalents.

Key Words: Pigs, Corn, Amino acid digestibility

1320 Effects of low-phytic acid corn on growth performance, bone strength, and serum osteocalcin concentration in growing-finishing pigs. M. W. Klunzinger*, K. D. Roberson, G. M. Hill, D. W. Rozeboom, and J. E. Link, Michigan State University.

A 91-d experiment was conducted to evaluate whether low-phytic acid corn (NDLP, Exseed Genetics) (90% phosphorus (P) availability) could replace dent corn (DC) without adversely affecting growth performance or bone parameters in growing-finishing pigs. Total P and phytate P were 0.24 and 0.16% in DC; 0.32 and 0.03% in NDLP, by analysis. Pigs were blocked by initial BW (18.5 to 22.5 kg) into four pens per treatment (trt) of eight crossbred pigs per pen. Two trts were fed; trt 1 contained DC and trt 2 contained NDLP. Three phases were fed; each was four wks in length. Dietary calcium and non-phytate P were computed to provide 0.75 and 0.36, 0.63 and 0.30, or 0.55 and 0.28% in phases I, II, and III, respectively. Total P was computed to provide 0.57, 0.50, or 0.47% for trt 1; and 0.47, 0.40, or 0.36% for trt 2, in phases I, II, and III, respectively. Dicalcium phosphate concentration was decreased by 0.73, 0.78, and 0.85% units in trt 2, for phases I, II, and III, respectively. One gilt per pen was chosen, based on average pen BW (92 to 106 kg), for slaughter at 91d. All third and fourth metacarpals (MC) and metatarsals (MT) were used to analyze bone-breaking strength. Blood was collected from two pigs per pen at 90d for serum osteocalcin (OC) analysis (an indicator of bone turnover). Gain/feed (trt 1 = 316, trt 2 = 350, $P > 0.09$), BW (trt 1 = 97.3 kg, trt 2 = 98.7 kg, $P > 0.71$), and ADG (trt 1 = 840 g/d, trt 2 = 860 g, $P > 0.57$) were not affected. There were no differences in bone strength of third and fourth MC and

fourth MT bones ($P > 0.28$). Overall, MC and MT bone strength was higher (15.04 vs. 12.83 MPa, $P < 0.01$) for gilts fed trt 1 vs. trt 2. This was due to a difference ($P < 0.01$) in third MT bone strength. Serum OC was not affected (trt 1 = 297 ng/mL, trt 2 = 276 ng/mL, $P > 0.92$), suggesting no difference in bone turnover. This study proposes that NDLP corn can be formulated with 90% P availability and replace dent corn without adversely affecting pig performance.

Key Words: Low-phytate corn, Bone strength, Pig

1321 Comparison of broiler performance when fed diets containing YieldGard® corn, YieldGard® and Roundup Ready® corn, parental lines, or commercial corn. M.L. Taylor*¹, G.F. Hartnell¹, M.A. Nemeth¹, B. George², and J.D. Astwood¹, ¹Monsanto Company, ²Colorado Quality Research.

Broiler chickens (Cobb x Cobb) were used to compare the broiler performance and processing parameters of YieldGard® corn (YG) and YieldGard® and Roundup Ready® corn (YG X RR) (both containing the Cry1A(b) protein and the latter also containing the maize EPSPS protein) with their parental lines and four commercial lines of corn. From days 1-20, broilers were fed a starter diet with approximately 50% w/w corn, and from days 20-42, broilers were fed a grower/finisher diet with approximately 60% w/w corn. Feed and water was provided ad libitum. Birds were housed in concrete floor pens and the environment controlled for light and temperature. Eight treatments (5 male and 5 female pens/treatment with 10 birds/pen) were assigned using a randomized complete block design. The standard randomized block analysis of variance (ANOVA) statistical model was used to analyze the data. Means were compared to each other at the 5% level of significance. An additional analysis compared the fit of YG corn and YG x RR corn with the population of responses from the commercial varieties using a linear mixed model procedure in SAS ($P < 0.05$). Performance parameters (live weight, feed intake on a per bird basis, feed efficiency, and adjusted feed efficiency) were similar ($P > 0.05$) among broilers fed the eight treatment diets. On a weight basis or percentage basis, carcass measurements of live/chill weight, thighs, drums (weight basis only), wings, and fat pad weights were similar across treatments ($P > 0.05$). Drum measurements as a percent of chill weight and breast meat weight were similar for YG corn and YG x RR corn and their parental lines and multiple commercial lines. No differences were observed in the percentage of moisture, protein, and fat in breast meat or thigh meat across treatments. Results support there were no biologically relevant differences in performance parameters, carcass yield, and meat composition between broilers fed the YG corn or YG x RR corn and their parental lines or commercial lines. In conclusion, YieldGard® corn and YieldGard® and Roundup Ready® corn were nutritionally equivalent to their corresponding parental lines and four commercial lines when fed to broilers.

Key Words: Corn, Broilers, Performance

1322 Comparison of swine performance when fed diets containing Roundup Ready® corn (GA21), parental line or conventional corn. E. P. Stanisiewski*¹, G. F. Hartnell¹, and D. R. Cook², ¹Monsanto Company, St. Louis, MO, ²Akey, Inc., Lewisburg, OH.

One hundred sixty pigs (80 barrows and 80 gilts) were used in a growth trial (72 to 117 kg body weight) to determine the effect of corn variety; Asgrow RX826, feed mill purchased corn (CPFM), Parental line DK626 and Roundup Ready® line DK626RR, on growth performance and carcass characteristics. Line DK626RR is a glyphosate-tolerant variety containing event GA21 (mEPSPS protein). Pigs were given ad libitum access to corn-soybean meal based diets and water throughout the trial. Each diet utilized one of the four corn varieties and all diets contained the same percentage of corn. Dietary amino acid levels were standardized across diets with crystalline amino acids. Barrows and gilts were penned (4 pigs per pen) separately in 1.5 × 2.4 m pens on concrete slats in a mechanically ventilated building. Pig and feeder weights were recorded weekly. Pigs were slaughtered at approximately 117 kg body weight and carcass data were collected. Over the duration of the trial, no significant ($P > .05$) gender by dietary treatment interactions were observed for any criteria measured. No significant differences ($P > .05$) were observed in response to corn variety for average daily body weight gain (ADG), average daily feed intake (ADFI) or feed efficiency (FE). As expected, barrows had greater ($P < .05$) ADG (880 vs 821 g/d) and

ADFI (2.81 vs 2.49 kg/d), and poorer ($P < .05$) FG (3.19 vs 3.03) compared with gilts. There were no overall treatment effects on chemical composition of muscle. Based on these data, DK626RR corn has a feeding value for pigs similar to its parental variety as well as commercially available varieties.

Key Words: Pigs, Corn

1323 Comparison of broiler performance when fed diets containing Roundup Ready® corn event NK603, parental line, or commercial corn. M.L. Taylor*¹, G.F. Hartnell¹, M.A. Nemeth¹, B. George², and J.D. Astwood¹, ¹Monsanto Company, ²Colorado Quality Research.

Broilers (Ross x Ross) were used to compare performance and processing parameters using the Roundup Ready® corn event NK603 containing the CP4 EPSPS protein with its parental line and five commercial lines of corn. From days 1-20, broilers were fed a starter diet with approximately 55% w/w corn; from days 20-42, broilers were fed a grower/finisher diet with approximately 60% w/w corn. Feed and water were provided ad libitum. Birds were in concrete floor pens and the environment controlled for light and temperature. Eight treatments (5 male and 5 female pens/treatment and 10 birds/pen) were assigned using a randomized complete block design. The standard randomized block analysis of variance (ANOVA) statistical model was used to analyze the data. Means were compared at the 5% level of significance. An additional analysis compared the fit of NK603 with the population of responses from the commercial varieties using a linear mixed model procedure in SAS. Performance parameters (live weight, feed intake, and feed efficiency) were similar ($P > 0.05$) among the broilers fed diets of the eight treatments. Carcass measurements of live/chill weight, breast meat (expressed as percent of chill weight), thighs, drums, and wings were similar across treatments ($P > 0.05$). Fat pad weights of broilers fed diets containing NK603 were not different from those fed diets containing one commercial line (1.5% vs 1.6% of live weight, respectively, $P > 0.05$) and were less than the parental line and four commercial lines (all 1.7% of live weight, $P < 0.05$). No differences were observed in percentages of moisture, protein, and fat in breast meat or protein and fat in thigh meat across treatments. Moisture content of thigh meat was similar between the NK603, parental, and three commercial lines and approximately 1% higher than NK603 in two commercial lines. The results of this study show that there were no biologically relevant differences in performance parameters, carcass yield, and meat composition between broilers fed the NK603 event, the parental, or commercial lines, and all data generated are similar to historical values for Ross x Ross strains. In conclusion, the Roundup Ready® corn line containing the NK603 event was nutritionally equivalent to its corresponding parental line and commercial lines when fed to broilers.

Key Words: corn, broilers, performance

1324 Growth performance of broilers fed insect-protected (MON 810) or near isogenic control corn. G. Piva*¹, M. Morlacchini², A. Pietri¹, F. Rossi¹, and A. Prandini¹, ¹Istituto di Scienze degli Alimenti e della Nutrizione, U.C.S.C., Facoltà di Agraria, Piacenza, Italy., ²CERZOO, Piacenza, Italy.

The aim of the present work was to compare the nutritive value for broilers of insect-protected (Bt) corn containing the Cry1A(b) protein (MON 810) with near isogenic control corn (IC), each grown on three Italian farms located in Lodi, Cremona and Venezia provinces. The study utilized 432 Ross male broilers (72 birds in four pens for each of the six treatments). Nutritional analytes were not different ($P < 0.05$) between IC and Bt corn. Diets were formulated to meet Ross broiler requirements and contained about 50% corn. Birds were fed diets for 42 days (first 21 days, grower phase; second 21 days, finishing phase). Feed intake, average daily gain (ADG) and feed:gain of birds fed Bt or IC corn did not differ ($P < 0.05$) regardless of the source of the Bt and IC corn. Final live weight of birds was significantly ($P < 0.05$) greater for the birds fed diets containing Bt corn as compared to IC corn from Lodi (2796 g vs 2707 g; $P < 0.05$; +3.3%) and Venezia (2619 g vs 2506 g; $P < 0.01$; +4.5%). When all performance variables from the birds fed the Bt treatments were averaged and compared with the mean of IC fed birds, ADG (63.4 vs 61.8 g/d), feed intake (125.7 vs 125.0 g/d) and feed:gain (1.98 vs 2.02) were similar ($P < 0.05$) and final live weight was 2.7% greater (2693 vs 2621 g; $P < 0.01$) for the Bt group. The difference could be due to Bt corn having a 72% lower level of fumonisin B₁

than IC corn. Aflatoxin and deoxynivalenol (DON) levels were low in all treatments. We conclude that performance of broilers fed Bt corn is at least as good as those fed IC corn.

Key Words: Broiler, Transgenic corn, Fumonisin B₁

1325 Evaluation of *Streptomyces lividans* and *Pichia pastoris* as extra-cellular expression systems for *Escherichia coli* phytase. C.H. Stahl* and X.G. Lei, Cornell University, Ithaca, NY.

Our previous research has shown that enzymatic properties and yield of individual phytases are greatly affected by the expression host utilized. The objective of this study was to determine the efficiencies of a bacterial (*S. lividans*) and a yeast (*P. pastoris*) system in expressing an *E. coli* phytase gene (*appA*), and to compare the thermo-tolerances, pH profiles, and optimal temperatures of the recombinant phytases. The *appA* was inserted into *S. lividans* TK24, after being cloned into a vector under control of the pLT1 promoter with the Spe2 signal peptide of endoglucanase E2 from *Thermomonospora fusca*. For expression in *P. pastoris*, *appA* was inserted into the vector pPICZaA (Invitrogen, San Diego, CA) under control of the AOX1 promoter, and transformed into *P. pastoris* X33. An active phytase was expressed and secreted into the media by both hosts. The protein expressed in *S. lividans* (SLEP) was not glycosylated and was the same size (approximately 45 KDa) as the de-glycosylated phytase expressed in *P. pastoris* (PPEP) that had multiple levels of glycosylation. Both enzymes had an optimal temperature of 65°C, but the relative activity of PPEP was 32 and 25% higher ($P \leq .05$), respectively, at 45 and 55°C, and 52% lower ($P \leq .05$) at 75°C than that of the SLEP. The pH optimum of SLEP was 4, and was between 3.5 - 4 for PPEP. At pH 2 - 3.5, PPEP had approximately 50% more ($P \leq .01$) relative activity than SLEP. The thermo-tolerance of SLEP was higher ($P \leq .05$) at 45 and 55°C, but lower ($P \leq .05$) at 65 and 75°C than that of PPEP. In conclusion, *S. lividans* can be used to produce an active extra-cellular phytase that may have different biochemical traits than the phytase produced by *P. pastoris*.

Key Words: Heterologous protein expression, Gene, *Streptomyces lividans*

1326 Apparent and true ileal digestibility of amino acids in soybean meals as affected by heat treatments and trypsin inhibitors. S. W. Kim*¹, Z. H. Zhang², L. A. Johnson³, and R. A. Easter², ¹Texas Tech University, ²University of Illinois, ³Iowa State University.

Heat treatment in producing soybean meal is an important factor affecting nutritional value of the material. Underheating can cause failure to eliminate trypsin inhibitors whereas overheating can reduce digestibility and availability of amino acids. This project was undertaken to investigate how different levels of heat treatment affect amino acid digestibility in growing pigs as it relate to the disappearance of trypsin inhibitors. Four soybean meals were processed under different cooking conditions. These treated soybean meals were compared with a control soybean meal and soy protein concentrate obtained from the Ohio State University. A casein based diet was used to measure endogenous protein losses based on the assumption that casein is fully digestible. The experiment were conducted as two replicates of 7 x 7 Latin Square. Fourteen surgically-cannulated pigs were used to determine ileal digestibility of amino acids in soybean meals. Both undercooking and overcooking of soybean meals decreased ($P < 0.05$) true and apparent ileal digestibility of amino acids. However adverse effect on ileal digestibility of amino acids was greater ($P < 0.05$) when soybean meals were undercooked than overcooked. Undercooked soybean meals contained significantly greater amount of trypsin inhibitors (38,300 and 32,800 TIU/g) than the control soybean meal (4,600 TIU/g) even though KOH solubilities of those soybean meals (78 and 69%) were close to that of control soybean meal (74%). The moderately overcooked soybean meal containing 15,700 TIU/g but a low KOH solubility (59%) had a lower ($P < 0.05$) true and apparent ileal digestibility of amino acids than control soybean meal but higher ($P < 0.05$) than undercooked soybean meals. Severely overcooked soybean meal had a low KOH solubility (40%) but the content of trypsin inhibitor (6,700 TIU/g) was close to that of control soybean meal. True and apparent ileal digestibility of amino acids were

lower ($P < 0.05$) than in control soybean meal but higher ($P < 0.05$) than in undercooked soybean meal.

Key Words: Ileal digestibility, Soybean meal, Pigs

1327 Effect of increased levels of crystalline nonessential amino acids on growth performance and nitrogen retention of broiler chicks fed low-CP diets. K. Bregendahl* and D.R. Zimmerman, *Iowa State University, Ames.*

In spite of meeting the requirements for essential AA, low-CP diets may not supply sufficient nonessential AA (NEAA) to sustain maximal growth performance of pigs and broiler chicks. Therefore, an experiment was conducted to investigate whether increased dietary levels of crystalline NEAA improve growth performance and N retention of broiler chicks fed low-CP diets. A total of 306 day-old broiler chicks was fed a common corn-soybean meal (SBM) diet (23% CP) for 1 wk, after which the chicks were allotted to one of five diets (D) in a completely randomized design (10 chicks per pen, 6 replications; 123 g initial BW). Chicks had free access to the isoenergetic diets (3.20 Mcal ME_n/kg), which were formulated to meet or exceed all NRC (1994) requirements. The diets consisted of a control diet (D1; 23.4% CP), D2 (18.3% CP), D3 (18.7% CP), D4 (19.4% CP), and D5 (20.3% CP). The CP content of D2 was reduced by altering the corn:SBM ratio in D1 and adding crystalline AA (Arg, Ile, Lys, Met, Thr, and Val) to 105% of NRC (1994) AA levels. Diets D3, D4, and D5 were formulated by replacing cornstarch in D2 with a 1:1 mix of Glu and Asp at 1, 2, and 3%, respectively. After 2 wk on test, chicks were weighed, fasted for 24 h, and two chicks per pen were euthanized. The whole-body N contents of the chicks fed D1 through D5 as well as six baseline chicks were determined. Treatment means were compared using orthogonal contrasts. Feed utilization (G:F; 0.753, 0.711, 0.716, 0.712, 0.723 for D1, D2, D3, D4, and D5, respectively) and N retention (1.19, 1.08, 1.10, 1.10, 1.11 g/d) of chicks fed D1 were superior ($P < 0.001$) to that of chicks fed D2 through D5, while ADG (43.9, 42.6, 42.5, 42.5, 42.6 g/d) and ADFI (58.3, 59.9, 59.4, 59.7, 59.0 g/d) did not differ ($P > 0.05$). No linear or quadratic effects ($P > 0.05$) of increasing the NEAA levels on ADG, ADFI, G:F, or N retention were observed. Based on these results, the inferior growth performance of chicks fed low-CP diets is not caused by a deficiency of NEAA.

Key Words: Low Crude Protein, Growth Performance, Nonessential Amino Acids

1328 Lysine to Protein ratios in growing-finishing pigs. E. O. Castaneda-Silva*¹ and J. A. Cuaron², ¹*Nutrimentos Concentra, S.A. de C.V.*, ²*C. N. I. Fisiología y Mejoramiento Animal, INIFAP, Queretaro, Mexico.*

Using sorghum-soy based diets, 3.23 Mcal ME/kg, two experiments were conducted to find the best total Lys concentration in dietary crude protein (CP), provided that other limiting amino acids (Thr, Trp, Met) were maintained in a constant (ideal) ratio to Lys, on a true ileal digestible basis. A nitrogen (N) balance experiment was conducted using 4 CP levels: 12, 15, 18 and 21% of the diet. In all cases, Lys was constant at 6% of CP. Twenty-four barrows, of an initial wt. of 47±2.8 kg were used. After a preliminary feeding period of 21-d, a 6-d total excretion collection phase was followed. Nitrogen retention was linearly increased ($P < .01$) by dietary CP: 18.58, 21.29, 21.21 and 24.73 g/d. In response to the increase in CP, efficiency of N retention was linearly decreased ($P < .01$): 43.20, 39.43, 34.12 and 34.10% of N intake. Giving equal importance to retention and efficiency of N retention, the best CP level was estimated at 14.7% of the diet. In Exp. 2, three Lys:CP ratios (5.0, 5.8 and 6.6%) were tested at 2 CP levels: 14.7 and 16.7% for growing (25-65 kg BW), and 13.5 and 15.5% for finishing pigs (66-107 kg BW). The CP level and the Lys:CP ratios interacted ($P < .05$) in voluntary feed intake, daily wt. gain and lean eye area. At lower CP, a positive linear response ($P < .01$) was observed after the increasing levels of Lys but, at higher CP, a quadratic effect ($P < .01$) was evident above the 5.8% ratio. Feed intake was: at lower-CP, 2.4, 2.3 and 2.5; at higher-CP, 2.4, 2.4 and 2.2 kg/d, in both cases for the 5.0, 5.8 and 6.6% Lys:CP ratios. In the same order, results for BW gain were: lower-CP, 0.72, 0.73 and 0.78; higher-CP, 0.74, 0.76 and 0.69 kg/d. Similarly, lean eye area was: lower-CP, 28, 32 and 30; higher-CP, 34, 30 and 33 cm². Following a broken line analysis, the best Lys:CP ratio was calculated as 5.8 Lys as % of CP.

Key Words: Lysine, Crude protein, Growing pigs

1329 Effect of synchronizing dietary protein and glucose supply on nitrogen retention of growing pigs. W.J.J. Gerrits*, K.P.C.M. Frijters, J.M. Linden, M.J.W. Heetkamp, T. Zandstra, and J.W. Schrama, *Wageningen Institute of Animal Sciences, Wageningen, The Netherlands.*

An experiment was conducted to test and quantify the effect of synchronizing the dietary supply of protein and glucose to pigs. Six barrows (40 kg) were subjected to one of two dietary treatments (synchronous or asynchronous supply of protein and glucose) in a change-over design. The synchronous treatment consisted of two complete meals: one at 0800 and one at 1600. At the asynchronous treatment, protein and starch were supplied in separate meals: the pigs consumed 95% of the daily protein supply with the 0800 meal and 99% of the starch supply with the 1600 meal. Daily intake of all nutrients and dietary ingredients was identical between the treatments. The gross energy intakes at 0800 and those at 1600 were equal for both treatments. Pigs were housed individually in climate controlled open circuit respiration chambers and fed at 2.1 x the energy requirements for maintenance. Faeces and urine were collected quantitatively for 13d. Heat production was measured by indirect calorimetry. Preliminary results indicate that synchronizing the dietary protein and starch supply did not affect apparent fecal digestibility of DM, N, energy, crude fat and ash (mean values of 88.5, 91.9, 88.9, 72.8 and 55.0, respectively; $P > 0.2$). It did, however, markedly increase N retention from 0.91 (asynchronous) to 1.08 g N/kg BW^{-0.75}·d⁻¹ (synchronous) ($P < 0.01$). The efficiency with which digestible N was retained increased from 49.5 (asynchronous) to 59.9% (synchronous; $P < 0.01$). Due to technical problems, the results of the heat production measurements could not be used. In conclusion, the results of this non invasive study illustrate the potential effect that synchronization of dietary protein and glucose supply may have on nitrogen retention.

Key Words: Pigs, Protein Metabolism, Nutrient Synchrony

1330 Portal recovery of enteral supplied alpha-ketoglutaric acid in growing pigs. N. B. Kristensen*¹, S. G. Pierzynowski², H. Jungvid², and J. A. Fernandez¹, ¹*Danish Institute of Agricultural Sciences, Tjele, Denmark*, ²*Gramineer Int. AB, Lund, Sweden.*

The present study was undertaken to study the portal recovery of alpha-ketoglutaric acid (AKG) fed to growing pigs. Five crossbreed Danish female pigs (50 ± 2 kg BW before surgery) were fitted with silicone catheters in A. iliaca externa, V. mesenterica and V. porta. The pigs were fed a barley-wheat-soybean meal based diet (3 % of BW/d). The average daily gain during the experimental period was 801 ± 55 g/d. During blood samplings the diet was divided equally into 24 daily meals, fed every hour and added 5 % (wt/wt) of glucose (Control) or 5 % (wt/wt) of AKG, i.e. 342 mmol of AKG / kg feed (AKGfeed). Three pigs received in a later experiment an equivalent amount of AKG by i.v. infusion into V. mesenterica (AKGiv). Portal blood flow was measured by down stream dilution of p-aminohippuric acid continuously infused into V. mesenterica. Blood plasma concentrations of AKG were measured by gas-liquid chromatography of O-ethylxime ethyl esters of AKG. The arterial concentration of AKG increased ($P < 0.01$) from 18 to 25 ± 3 μmol/l with Treatment AKG compared with control. With Treatment AKGiv, the arterial concentration of AKG was 425 ± 27 μmol/l. The portal blood flow was not obtained for all pigs, however, the data obtained did not indicate any treatment effect on portal blood flow (131 ± 6 l/h; n=9). The portal net appearance of AKG (calculated as whole blood flux) increased ($P < 0.01$) with Treatment AKGfeed (35 ± 9 mmol/ kg feed) compared with control (9 ± 5 mmol/kg feed). The increased net portal appearance of AKG could account for 8 ± 2 % of the AKG added to the feed. When AKG was infused into the mesenteric vein it could be completely accounted for (100 ± 2 %) in the portal vein. These results suggest that enteral supplied AKG has a low availability (8 %) for liver and peripheral tissues in pigs. Thus a large fraction of AKG is probably metabolized within the digestive tract or in the intestinal mucosa.

Key Words: Alpha-ketoglutaric acid, Digestive absorption, Pigs

1331 The change of growth performance and carcass characteristics in finishing pigs treated with N-methyl-D,L-aspartate(NMA). Gang Xi¹, Zirong Xu², and Ping Xiao², ¹University of Minnesota, St. Paul, MN, ²Zhejiang University, Hangzhou, China.

A total of 84 cross bred finishing pigs (average initial BW of 56±0.37 kg) were used to determine the effect of dietary N-methyl-D,L-aspartate(NMA) on growth performance and carcass characteristics. There were 14 pigs (7 gilts and 7 barrows) per pens and 3 pens for each treatment. Treatments were: 1) corn-soybean meal without NMA; 2) added 50 mg/kg NMA to the diet. All pigs were given free access to feeds and water. After feeding trial, 8 pigs from each treatment (4 gilts and 4 barrows) were sacrificed to determine the carcass traits. The addition of NMA in diet improved the ADG 9.31% ($p < .01$) and the G/F 7.66% ($p < .02$) in finishing pigs. No difference was observed in ADFI between two treatments. Pigs fed NMA had 6.54% higher ($p < .01$) carcass lean proportion and 21.01% larger ($p < .04$) longissimus muscle area(LMA) compared to pigs fed the control meal. In addition, the carcass fat proportion of NMA treated pigs was 11.76% lower ($p < .01$) and back fat depth (10th rib) was 19.72% less ($p < .01$) than that of pigs without NMA in diet. There were no differences in dressing percentage, carcass skin proportion, and carcass bone proportion between two treatments. The weight of longissimus muscle, biceps femoris, and Semimembranosus were improved with 12.30% ($p < .01$), 10.09% ($p < .01$) and 14.44% ($p < .01$), respectively, with addition of NMA in diet, but no differences were found in quadriceps femoris and semitendinosus. Also, there were no differences in weight percentage of brain, heart, liver and kidney between two treatments. These results suggest that addition of 50 mg/kg NMA in diet will improve the ADG, G/F and increase muscle production and reduce the accretion of body fat in finishing pigs.

Key Words: NMA, Growth Performance, Carcass Characteristics

1332 Response of weanling pigs to dietary lysine sulfate fermentation product or L-lysine-HCl supplementation. B. R. Frederick* and E. van Heugten, North Carolina State University, Raleigh.

Two trials involving a total of 192 weanling pigs, 7.3 and 6.6 kg initial BW for trial 1 and 2 respectively, were conducted to determine the effect of a lysine-SO₄ fermentation product (Biolys[®] 60, containing 46.8% free + 0.5% protein bound L-lysine) on pig performance. In each trial, 96 pigs (4 pigs/pen) were weaned and fed a commercial, prestarter diet for 8 d in trial 1 and 5 d in trial 2 to ensure adequate dietary adjustment to solid food. At that time pigs were allotted by weight to one of three lysine supplementation treatments: 1) control containing 0.90 and 0.70% lysine for the prestarter and starter period, respectively, 2) control with 0.20% lysine from L-lysine-HCl, or 3) control with 0.20% lysine from lysine-SO₄ product. Diets contained 110% of the ideal amino acids:lysine ratio and were iso-nitrogenous and iso-energetic within each period. Pigs consumed the prestarter, experimental diets for 7 d and 14 d and the starter, experimental diets for 24 d and 21 d in trial 1 and 2, respectively. Pigs were allowed free access to feed and water for the duration of the study. Data were analyzed as a randomized complete block design blocked by weight and pen was used as the experimental unit. Pigs fed the lysine-supplemented diets consumed more feed ($P < 0.001$) than control pigs, 814 vs 675 20 g/d in trial 1 and 520 vs 435 ± 17 g/d in trial 2, respectively. Lysine supplementation increased average body weight gain ($P < 0.001$) compared to the control, 457 vs 320 ± 11 g BW gain/d in trial 1 and 315 vs 226 ± 11 g BW gain/d in trial 2, respectively. Furthermore, lysine supplementation improved efficiency of feed utilization ($P < 0.001$) compared to the control, 563 vs 478 ± 8 g BW gain/kg feed intake in trial 1 and 607 vs 519 ± 8 g BW gain/kg feed intake in trial 2, respectively. However, feed intake, body weight gain, and efficiency of feed utilization did not significantly differ ($P > 0.05$) between L-lysine-HCl and lysine-SO₄ product treatments for the duration of both trials. Therefore, lysine-SO₄ product is a possible alternative to L-lysine-HCl in commercial, weanling pig diets.

Key Words: Pig, Lysine, Sulfate

1333 Effects of dietary supplementation of crystalline L-glutamine on the gastrointestinal tract and whole body growth in early-weaned piglets fed corn and soybean meal-based diets. D. Lackeyram*¹, X. Yue¹, and M.Z. Fan¹, University of Guelph, Guelph, Ontario, Canada.

This experiment was conducted to examine the effect of dietary supplementation of crystalline L-glutamine on the gastrointestinal tract and whole body growth in early-weaned piglets. A total of 36, 10-d old piglets with an average initial BW of 3.5 kg were used. Piglets were blocked by replication time, equalized for gender and allocated randomly to one of four dietary treatments in a randomized complete block design. Piglets were housed individually in an environmentally controlled room at 25 degrees Celsius with heating lamps in rubberized-floor pens. The control diet (GC) (n=18) contained 56% soybean meal and 16% corn and was formulated to meet NRC (1998) requirements for all nutrients. Three treatment diets (n=6) were formulated by supplementing the control diet with crystalline L-glutamine at the level of 0.8 (Gln1), 1.6 (Gln2), and 2.4% (Gln3), respectively. Diets were fed for a period of 12-d and piglets were allowed free access to feed and water. Piglets weaned on the Gln1 diet had a 59% greater ($P \leq 0.01$) BW gain than the control group (92.4 ± 16.1 vs. 57.9 ± 10.9 g/d), whereas piglets fed the Gln2 and Gln3 diets did not differ ($P \geq 0.01$) from the GC-fed animals. Piglets fed the Gln1 diet had heavier ($P \leq 0.01$) stomachs than the control animals (0.61 ± 0.05 vs. 0.45 ± 0.04 g/kg BW/d). A 53 and 74% increase ($P \leq 0.01$) in the weights of the small intestine in piglets fed the diets Gln1 and Gln2 were observed (1.10 ± 0.13 and 1.25 ± 0.14 vs. 0.72 ± 0.17 g/kg BW/d) respectively. Similar increases ($P \leq 0.01$) in liver weight gains were observed between the GC and the Gln1, Gln2 and Gln3 groups (-0.04 ± 0.09 vs. 0.48 ± 0.21; 0.44 ± 0.16 and 0.22 ± 0.17 g/kg BW/d). These results suggest that the inclusion of crystalline L-glutamine at a level of 0.8% in corn soybean meal-based diets is effective in enhancing the BW gain, the small intestine growth and other visceral organ growth in early-weaned piglets, however the level of supplementation higher than 1.6% did not induce such effects.

Key Words: L-Glutamine, The gastrointestinal tract growth, Early-weaned piglets

1334 The performance and protein, amino acid and phosphorus utilization of piglets were improved by phytase supplementation. Keying Zhang*, Daiwen Chen, Bing Yu, Xianmei Luo, and Yongyi Li, Institute of Animal Nutrition, Sichuan Agricultural University, Yaan, Sichuan 625014, P.R. China.

Efficacy of phytase in improving utilizations of dietary protein and amino acids needs to be further investigated. In this study, forty eight Yorkshire x Landrace were used in two balance trials to study the performance and nutrient utilizations of 40-days-old pigs fed diets with or without supplementation of microbial phytase at the dose of 500 units per kg diet. In trial one, phytase was added into diets of normal available phosphorus (AP) (0.36%) or low level AP(0.26%). The decrease of AP from 0.36% to 0.26% resulted in the decrease of average daily gain (ADG), feed intake (FI) and feed conversion rate (FCR) by 17.2, 7.4% and 11.2 respectively ($P < 0.01$). ADG, FI and FCR were improved by 10.8%, 6.5% and 3.5% respectively after the addition of phytase ($P < 0.05$). The improvement was greater for phytase addition into 0.26% AP than into 0.36% AP. The supplementation of phytase in 0.36%-AP diet did not affect the digestibilities of phosphorus(P)protein (CP) and amino acids(AA), and the retention of P. But CP biological value (BV) was improved by 3.3($P < 0.05$). However, phytase in 0.26%-AP diet improved P digestibility, P retention and BV of CP by 12.8, 13.1 and 16.0 respectively ($P < 0.05$). In trial two, two diets were designed with same AP (0.26%) but different lysine level (0.97% vs 0.92%). The decrease of lysine from 0.97% to 0.92% reduced ADG, FCR ($p < 0.01$), and BV of CP (54.7% vs 51.5%) ($P < 0.1$), but enhanced essential AA ileal digestibility $p < 0.05$. The addition of phytase improved ADG and FCR ($p < 0.01$), P digestibility and retention ($P < 0.01$), BV of CP ($p < 0.25$) and lysine ileal digestibility ($p < 0.25$), with greater improvement at higher than lower dietary lysine level. It is concluded that dietary supplementation of 500U phytase /kg can significantly improve the performance of piglets and the utilizations of phosphorus and protein. The extent of improvement is affected by the dietary phosphorus and lysine level.

Key Words: Phytase, Nutrient Utilization, Piglets

1335 Metabolic adaptation to synthetic feed and different amino acid patterns. J. A. Nolles, V. V. A. M Schreurs, R. E. Koopmanschap, and M. W. A. Verstegen*, *Wageningen Institute of Animal Sciences (WIAS)*.

Metabolic adaptation to free amino acids as well as to 3 different methionine (MET) levels in the feed was studied in 36 male Wistar rats, assigned to 6 groups with 3 different dietary groups. The dietary groups were subdivided in an adaptation and a nonadaptation group. All diets contained 21% free amino acids. The pattern was equal to casein protein, except for MET. Diet 1; MET level 50%, diet 2; 100% and diet 3; 200%. Postprandial oxidation of $1\text{-}^{13}\text{C}$ -methionine (13MET) was measured during 5 hours after a meal (t_0 = start meal, t in min) by recovery of $^{13}\text{CO}_2$ in the breath, expressed as rate % dose/30 min or cumulative % dose. For each diet, the nonadaptation group was tested after 5 days, the other group was tested after an adaptation period of 3 weeks. Incorporation of 13MET in several tissues was measured at $t = 300$, expressed as At % excess. Statistical analysis; t-test with Bonferroni correction. Nonadaptation groups: There was no difference in the oxidation rate between the 100% and the 50% group at $t = 150$ (2.4 0.27 vs 2.3 0.47 % doses/30 min). The 200% group was significantly higher (peak value 3.6 % doses/30 min 0.38, on $t = 150$). Our results indicate that percental oxidation rate in time of MET remains equal under normal and low MET supply. Only extreme high levels (200% group) cause an acute raise in oxidation. Adaptation to the diets caused a time lag of 60 minutes for maximal oxidation rate in all dietary groups. However the peak and the cumulative values did not change for the 100% (2.6 0.15 at $t = 210$, cumulative 20.3 0.51) and the 200% (3.5 0.10 at $t = 210$, cumulative 27.1 0.80) groups. Only the 50% group had a lower peak (1.6 0.12 at $t = 210$) and cumulative oxidation (11.8 0.44) after the adaptation period. Tissue samples of all organs showed that the incorporation of MET was the highest in the 50% group. The most pronounced result of this experiment was the adaptation effect on organ level. In general after the adaptation period 10 to 20% more 13MET was incorporated in all dietary groups. However the longissimus showed for all groups an increase of 40 to 50%. We therefore concluded that muscles play an important role in adaptation to different amino acid patterns in the feed.

Key Words: Breath-test, Adaptation, Amino Acids, Methionine, Protein Metabolism

1336 Cysteine and sulfite enhance reduction of trypsin inhibitor during heating of soybeans. Y.X. Huang and E.L. Miller*, *Department of Clinical Veterinary Medicine, University of Cambridge*.

Heat treatment of soybeans is a compromise to reduce trypsin inhibitor without causing protein damage. The objective was to determine whether sulfitolysis of disulfide bonds with cysteine or sulfite reduces trypsin inhibitor (TI) content of soya and can reduce the extent of heat treatment needed for reduction of TI. Dehulled soybeans were ground and extracted with petroleum spirit and adjusted to moisture of 100, 140, 180, 220 g/kg. The initial TI was 65 mg/g DM and 4.84 (SD 0.043) mmole/kg DM reactive SH determined with 4,4'-dithiodipyridine. Samples (4 g) of extracted soya were heated in screw cap test tubes at 99C for 5 minutes to rapidly bring the sample to temperature and then heated 10, 20, 40 and 60 minutes at 95C. TI decreased very little at 100 g/kg moisture but more rapidly with increased moisture. Reactive SH groups followed a similar pattern. TI was related exponentially to SH ($\text{TI mg/g} = 0.2124e^{1.1512x}$; $r = 0.923$) where x is SH mmole/kg. Urease activity (pH change) was linearly related to SH ($y = 0.6699\text{SH} - 1.2458$; $r = 0.939$). The rate of loss of TI under each moisture condition was determined as a second order reaction (reciprocal of TI v time plot). The moisture-adjusted soya was mixed with sodium metabisulfite (S) at the rate of 11.8 g/kg DM or with cysteine (C) at 15 g/kg DM, each supplying 0.25 mole SH per kg protein, and heated as for soya alone. Unreacted S or C were removed by washing and centrifugation over a 10,000 dalton membrane. Addition of C and S increased reactive SH. Values (mmole/kg DM) at 220 moisture for soya: 4.80, 4.48, 3.84, 3.57, 2.82; S 6.04, 7.39, 8.17, 6.19, 4.07; C 7.34, 10.49, 8.25, 11.99, 4.31 at 0, 10, 20, 40, 60 min. Addition of C did not increase loss of TI at 100 or 140 g/kg moisture but increased the rate of loss 1.9 and 3.3 times at 180 and 220 g/kg moisture. S was more active increasing rate of TI loss 3.0, 5.8, 6.2 times at 140, 180 and 220 g/kg moisture. Heating moist soya alone reduced reactive SH groups. Heating in the presence of S or

C decreased the time to reduce TI to low levels and increased reactive SH.

Key Words: Trypsin inhibitor, Sulfhydryl, Sulfitolysis

1337 Effect of Zinc-Methionine on growth performance of Japanese quail (*Coturnix coturnix japonica*) fed with starting-growing diets. A. Montoya*¹, R. Barajas¹, and G. Contreras¹, ¹*FMVZ-Universidad Autonoma de Sinaloa*.

With the objective of determinate the effect of Zinc-Methionine on growth performance of Japanese quail fed with starting-growing diets, a complete randomized design experiment was conducted. Six hundred Japanese quail, one day old (male and female; BW = 10.4 g) were used. The animals were randomized divided in 12 groups of 50 quails. Each group was allocated in metallic crates with cement floor provided with wood saves. The quails were assigned to consume one of two diets in that consisted the treatment: 1) Diet with 21% CP and 3.2 Mcal DE/kg (CodoriniciarinaTM; PURINA MILLS, CO.) containing 40 ppm of Zn from unknown source (control); and 2) Diet similar to control, supplemented with additional 25 ppm of Zn from zinc-methionine (ZINPRO-100TM; ZINPRO,CO.) designed as Zn-Met treatment. Quails were weight at starter and end of experiment (28 days), feed intake was recorded weekly, mortality were recorded daily, and animal deaths were not replaced. The data were analyzed as a complete randomized design experiment with six repetitions, taken a crate (50 quails) as one observation. Final weight was not affected ($P > 0.10$) by treatments (mean = 193.5 g). Daily feed intake of the experiment was 18.94 g/day and a similar ($P > 0.10$) for both treatment. The average daily gain of the experiment was 6.54 g/day, and was not influenced ($P > 0.10$) by treatments. Zn-Met not improved ($P > 0.10$) feed efficiency (experiment mean 0.35 kg gain/kg food). Mortality was unaffected ($P > 0.10$) for Zn-Met supplementation (7.0 vs 6.67%). It is concluded, that supplementation with 25 ppm of Zn from Zn-Met to starting diets do not improve growth performance of Japanese quail.

Key Words: Zinc, Supplementation, Japanese quail

1338 Effect of chromium-methionine level in diet on hatchability of Japanese quail in dry tropic weather:II. Response under temperature-controlled in winter season. G. Contreras*¹ and R. Barajas¹, ¹*Universidad Autonoma de Sinaloa*.

To determinate the effect of chromium-methionine level in diet on hatchability of Japanese quail in dry tropic weather under temperature-controlled in summer season, a completely randomized design experiment was conducted (four treatments; ten replicates by treatment). Thousand two hundred eighty Japanese quail (960 females and 320 males), they were divided in 160 groups of eight (six females and two males), and were allocated in wire cages (25 x 30 cm); groups of four cages (32 quails) formed an observation. The avian were randomized assigned to consume diets (21% CP; 2.9 Mcal DE/kg), in that consist the treatments, containing one of four levels (0, 100, 200 and 400 ppb) of supplemental chromium from chromium-methionine (MicroplexTM Zimpro,CO.MN). Mean daily feed intake by quail in the experiment was 31.7 g and was not affected ($P > 0.10$) by treatments. The hatching was increased 12% ($P < 0.05$) with Cr 100 ppb treatment. Percentage of egg hatching was not affected ($P > 0.10$) by treatments (74%). Level of 100 ppb of Cr increased ($P < 0.05$) in 22% the number of newly born quails by day (103 vs 84) with respect to zero Cr level, cubic effect ($P < 0.05$) of Cr-Met supplementation was found (84, 103, 88 and 92 newly born quails for 0 to 400 ppb of Cr in diet). Hatchability in Cr-400 was higher ($P < 0.05$) than control (64.8 vs 74%), a linear effect of chromium was detected ($P < 0.05$). The weight of newly born quail was diminished ($P < 0.05$) by chromium levels of 100 and 200 ppb with respect of Cr 0 ppb treatment, a quadratic ($P < 0.01$) effect of chromium was observed, with values of 10.17, 9.82, 9.7 and 10.12 g for chromium levels of 0, 100, 200 and 400 respectively. It is concluded, that 100 ppb of supplemental Cr from Cr-Met, improve hatching and newly born quails by day of Japanese quail in dry tropic weather under temperature-controlled in winter season.

Key Words: Japanese quail, Chromium, Hatchability

1339 Effect of chromium-methionine level in diet on hatchability of Japanese quail in dry tropic weather: I. Response under temperature-controlled in summer season. G. Contreras*¹ and R. Barajas¹, ¹Universidad Autonoma de Sinaloa.

To determinate the effect of chromium-methionine level in diet on hatchability of Japanese quail in dry tropic weather under temperature-controlled in summer season, a completely randomized design experiment was conducted. Thousand two hundred eighty Japanese quail (960 females and 320 males), they were divided in 160 groups of eight (six females and two males), and were allocated in wire cages (25 x 30 cm); groups of four cages (32 quails) formed an observation. The avian were randomized assigned to consume diets (21% CP; 2.9 Mcal DE/kg), in that consist the treatments, containing one of four levels (0, 100, 200 and 400 ppb) of supplemental chromium from chromium-methionine (MicroplexTMZinpro,CO.MN). Chromium 100 ppb increased ($P < 0.05$)

the average daily feed intake with relation of the remainder treatments (36.9 vs 36.3 g/day). The hatching was not affect ($P > 0.20$) by treatments (mean value = 78%); egg hatching was similar ($P > 0.20$) across treatments (66%). Supplementation with level of 100 ppb of Cr increased ($P > 0.05$) in 19% the number of newly born quails by day (81 vs 68), and hatchability in 22% (55 vs 67.5%) with respect to control (Cr 0 ppb). Levels of 200 and 400 ppb tended ($P = 0.11$) to decrease in 18% the number of newly born quails by day (68 vs 56) respect to control. Chromium 200 and 400 ppb had similar ($P > 0.20$) hatchability than control (55 vs 46%). It is concluded, that 100 ppb of supplemental Cr from Cr-Met, improve hatchability and newly born quails by day of Japanese quail in dry tropic weather under temperature-controlled in summer season.

Key Words: Japanese quail, Chromium, Hatchability

PSA Nutrition: Amino Acids, Feed Ingredients, and Feed Processing

1340 Digestible lysine levels in the diets of broilers from 1 to 21 days of age. L. F. Araujo*¹, O. M. Junqueira¹, C. S. S. Araujo¹, and S. M. Baraldi Artoni¹, ¹Universidade Estadual Paulista - UNESP/Jaboticabal - SP - Brazil.

The purpose of this experiment was to evaluate different levels of digestible lysine on performance of chickens from 1 to 21 days of age. A total of 1000 one day-old chicks was fed diets with 5 levels of digestible lysine (1.18%; 1.30%; 1.42%, 1.54% and 1.66%) in four replications of 50 birds each. The same ideal relationship of Lis:Met+Cis:Met:Thr (100:71:39:63) was maintained in all diets. The basal diet was formulated according to the recommendations of Rostagno et al. (2000) with 3,100 kcal ME/kg and 22% crude protein. At 21 days of age, the best results were observed in broilers fed the diet containing 1.18% digestible lysine. As the level of digestible lysine increased in the diet, there was a reduction in feed intake, affecting weight gain. So that, the 1.66% level of digestible lysine produced lower weight gain and poorest feed conversion. From the results obtained in this experiment, it is possible to conclude that 1.18% digestible lysine is enough to maintain the requirements of broilers from 1 to 21 days of age. Financial Support: FAPESP. Proc. 98/06355-3

Key Words: Broilers, Lysine, Performance

1341 Dietary crude protein levels needed for broilers from three to six weeks of age as influenced by gender. Q. Jiang*, C. A. Fritts, and P. W. Waldroup, *University of Arkansas.*

Development of crystalline amino acids have allowed for a reduction in overall crude protein content in broiler diets. However at some point performance declines even though all nutrient recommendations are provided. The objective of this study was to determine the minimum level of CP that might be needed by broilers from three to six weeks of age. Because some studies have suggested that males and females may differ in their response to CP or amino acids, separate sex feeding of diets with different levels of crude protein was examined. Diets were formulated using corn and soybean meal of known composition to provide diets with 15 to 20% CP in increments of 1%. Crystalline amino acids were used to provide at least 100% of NRC (1994) recommendations. Dietary electrolyte balance was maintained at a minimum of 200 meq/kg. From one to 21 d of age chicks were fed 24% CP and then placed on test diets from 21 to 42 d. Body weight gain and feed conversion were determined and samples of birds processed at 42 d. Four pens of 25 males and four pens of 25 females were fed each CP level. Although males differed significantly from females in BW gain or feed conversion there were no significant interactions of gender and CP level. Diets with 17% supported BW and FCR that did not differ from that of birds fed diets with higher levels; lower CP levels resulted in a significant reduction in performance. Females had a higher percentage of breast meat and greater amounts of abdominal fat than males but there were no interactions between dietary CP and gender for any parts yield. A CP level of 17% supported breast yield equal to that of higher levels.

Key Words: Crude protein, Gender, Carcass yield

1342 mRNA that encode for proteins capable of transporting L-methionine and/or dl-2-hydroxy-4-(methylthio) butanoic acid are present in the intestinal epithelium of broilers. Y-X. Pan*¹, E. A. Wong¹, J. J. Dibern², and K. E. Webb, Jr. ¹, ¹Virginia Tech, Blacksburg, VA, ²Novus International, Inc., St. Charles, MO.

The presence of mRNA that encode for proteins capable of transporting L-methionine (L-Met) and/or dl-2-hydroxy-4-(methylthio) butanoic acid (HMB) in broiler intestinal epithelium was examined. Total RNA was extracted from duodenal, jejunal, and ileal epithelium collected from male broilers (42 d old, BW 2.03 kg). Poly(A)⁺ RNA was isolated and size-fractionated by sucrose-gradient centrifugation when needed. Healthy oocytes at stage V-VI were collected from *Xenopus laevis* and then microinjected with either water, poly(A)⁺ RNA, or size-fractionated poly(A)⁺ RNA. The ability of the injected oocytes to uptake either L-Met or HMB was examined by incubating oocytes with [³H]-L-Met or [¹⁴C]-HMB 3-6 d post-injection. A greater uptake of L-Met ($P < 0.001$) and HMB ($P < 0.05$) by oocytes injected with poly(A)⁺ RNA from all three segments of the small intestine was observed compared with water-injected oocytes. The greatest ($P < 0.05$) uptake occurred when poly(A)⁺ RNA from the jejunum or ileum were injected. Injections from four different pools of sucrose gradient-fractionated poly(A)⁺ RNA from all three intestinal segments induced more ($P < 0.01$) L-Met uptake than did water injection. There were three, four, and four different pools of sucrose gradient-fractionated poly(A)⁺ RNA from the duodenum, jejunum, and ileum, respectively, that induced more ($P < 0.05$) HMB uptake than did water. Uptake of HMB was greater at pH 5.5 than at pH 7.5 and was independent of Na⁺. Uptake of L-Met induced by all four poly(A)⁺ RNA pools decreased dramatically when Na⁺ was removed from the uptake buffer, which indicated that the majority of L-Met uptake was Na⁺-dependent. These results indicate that there are multiple mRNA that encode for proteins capable of mediated transport of L-Met and/or HMB present in broiler intestinal epithelium.

Key Words: *Xenopus*, Chicken, Absorption

1343 Effects of amino acids and calcium levels on radiographic density and calcium excretion in broilers from 1 to 21 days of age. C. S. S. Araujo*¹, S. M. Baraldi-Artoni¹, L. F. Araujo¹, M. J. Q. Lousada², and O. M. Junqueira¹, ¹Universidade Estadual Paulista - UNESP/Jaboticabal - SP - Brasil, ²Universidade Estadual Paulista - UNESP/Araatuba - SP - Brasil.

An experiment was conducted in broilers to determine the effects of amino acids (AA) and calcium (Ca) levels on bone development and calcium excretion from 1 to 21 days of age. A total of 540 one-day old Avian Farms male chicks were randomly assigned to 6 treatments in a 3x2 factorial arrangement, considering the factors AA levels (100, 125 and 150% NRC, 1994) and Ca levels (75 an 100% NRC, 1994), in three replications and 30 birds each. The AA analyzed were methionine, lysine and threonine. Diets and water were available free choice. Experimental diets were comprised primarily of corn and soybean meal and were formulated to be isocaloric and isoproteic. Requirement levels for AA were accomplished when necessary by adding crystalline AA. Bone development was determined through radiographic density and tibia variables (tibia weight, tibia length, compact bone thickness and spongy bone

thickness). Total fecal output was collected for 72 h from days 19 to 21 to determine the treatment effect on Ca excretion. Percentage Ca excretion was calculated as grams of Ca in feces divided by grams of Ca consumed in the 72-h period. At 21 days, two broilers from each pen were slaughtered and the left tibia of the birds were collected and analyzed according to radiographic density (mm Aluminium equivalent). There were interactions in the trial between AA level and Ca level for radiographic density ($P < 0.05$). However, the results showed that AA or Ca levels did not affect tibia variables and Ca excretion. Acknowledgements: FAPESP for financial and technical support .

Key Words: Amino Acids, Calcium , Broilers

1344 Effects of amino acids and calcium levels on radiographic density and calcium excretion in broilers from 22 to 42 days of age. C. S. S. Araujo*¹, S. M. Baraldi-Artioni¹, L. F. Araujo¹, M. J. Q. Louzada², and O. M. Junqueira¹, ¹Universidade Estadual Paulista - UNESP/Jaboticabal, SP - Brazil, ²Universidade Estadual Paulista - UNESP/Araatuba, SP - Brazil.

The purpose of this experiment was to evaluate different levels of amino acids (AA) and calcium (Ca) on radiographic density (mm Aluminium equivalent), tibia variables (tibia weight, tibia length, compact bone thickness and spongy bone thickness) and Ca excretion from 22 to 42 days of age. A total of 540 one-day old Avian Farms male chicks were randomly assigned to 6 treatments in a 3x2 factorial arrangement, considering the factors AA levels (100, 125 and 150% NRC, 1994) and Ca levels (75 and 100% NRC, 1994), in three replications and 30 birds each. The AA analyzed were methionine, lysine and threonine. Diets and water were available free choice. Experimental diets were comprised primarily of corn and soybean meal and were formulated to be isocaloric and isoproteic. Requirement levels for AA were accomplished when necessary by adding crystalline AA. Total fecal output was collected for 72 h from days 40 to 42 to determine the treatment effect on Ca excretion. Percentage Ca excretion was calculated as grams of Ca in feces divided by grams of Ca consumed in the 72-h period. At 42 days, two broilers from each pen were slaughtered and the tibia left of the birds were collected and analyzed according to radiographic density (mm Aluminium equivalent). The AA or Ca levels unaffected radiographic density, tibia variables and Ca excretion. There were found interactions between the two factors. Acknowledgements: FAPESP for financial and technical support .

Key Words: Amino Acids, Calcium, Broilers

1345 Effects of amino acids and calcium levels on radiographic density and calcium excretion in broilers from 43 to 49 days of age. S. M. Baraldi-Artioni¹, C. S. S. Araujo*¹, L. F. Araujo¹, O. M. Junqueira¹, M. J. Q. Louzada², and N. K. Sakomura¹, ¹Universidade Estadual Paulista - UNESP/Jaboticabal, SP - Brazil, ²Universidade Estadual Paulista - UNESP/Araatuba, SP - Brazil.

Male broiler Avian Farms (n=540) were used from 43 to 49 days of age were subjected to a 3x2 factorial design consisting of three levels of dietary amino acids (100,125 and 150% NRC, 1994) and two levels of dietary calcium (75 and 100% NRC, 1994) with a total of 6 treatments replicated three times per treatment. Radiographic density (mm Aluminium equivalent), tibia variables (tibia weight, tibia length, compact bone thickness and spongy bone thickness) and Ca excretion were evaluate. The AA analyzed were methionine, lysine and threonine. Diets and water were available free choice. Experimental diets were comprised primarily of corn and soybean meal and were formulated to be isocaloric and isoproteic. Requirement levels for AA were accomplished when necessary by adding crystalline AA. Total fecal output was collected for 72 h from days 47 to 49 to determine the treatment effect on Ca excretion. Percentage Ca excretion was calculated as grams of Ca in feces divided by grams of Ca consumed in the 72-h period. At 49 days, two broilers from each pen were slaughtered and the tibia left of the birds were collected and analyzed according to radiographic density (mm Aluminium equivalent). The AA or Ca levels unaffected radiographic density, tibia variables and Ca excretion. There were found interactions between the two factors. Acknowledgements: FAPESP for financial and technical support.

Key Words: Amino Acids, Broilers, Calcium

1346 Effect of diets containing cashew nut meal and an enzyme complex on broiler performance. M.F.F. Fuentes*¹, S.F. Militao¹, E.R. Freitas¹, and G.B. Espndola¹, ¹Universidade Federal do Cear, Fortaleza, CE, Brasil.

An experiment was conducted to evaluate the effect of diets containing different levels of cashew nut meal (CNM) supplemented or not with an enzyme complex (Avizyme[®]) on broiler performance. One hundred and forty four day-old broiler chicks were allotted in individual cages during a period of 42 days. Birds were distributed in a randomized complete block design with six treatments and six replicates of four birds in each experimental unit. A factorial arrangement 3 x 2 (CNM x Enzyme) was applied. Diets used during the initial (1 to 21 days) and final (22 to 42 days) periods were isoproteic and isocaloric and contained 22% crude protein with 3,000 kcal ME/ kg and 20% crude protein with 3,100 kcal ME/ kg, respectively. Treatments were: T1 = 0% CNM; T2 = 0% CNM + 0.1% enzyme; T3 = 7.5% CNM; T4 = 7.5% CNM + 0.1% enzyme; T5 = 15% CNM; T6 = 15% CNM + 0.1% enzyme. Data were analyzed for the whole period (42 days). Results showed that the inclusion levels of CNM and the enzyme supplementation did not significantly ($P > 0.05$) affect body weight gain or feed intake. CNM levels, however, significantly ($P < 0.05$) affected feed conversion. Birds fed the diet containing 15% of CNM had better feed conversion than those fed the 0% and 7.5% CNM diets. Abdominal fat level in birds fed the diet with 7.5% of CNM was significantly ($P < 0.05$) lower than that from birds fed 15% CNM diet. Enzyme addition, however, did not affect this variable. It is concluded that bird performance was influenced by the level of CNM but not by the addition of enzyme to the diet.

Key Words: Cashew Nut Meal, Enzymes, Feed Conversion

1347 Dehydrated poultry meal as a replacement for soybean meal in broiler diets. J.B. Hess*¹, J.P. Blake¹, R.A. Norton¹, K.M. Downs², A. Kalinowski¹, and A. Corzo¹, ¹Poultry Science Department, Auburn University, Auburn, AL, ²Middle Tennessee State Univ., Murfreesboro, TN.

An experiment was conducted to evaluate broiler live performance in birds fed varying levels of a locally-produced dehydrated poultry meal (DPM) in place of soybean meal (SBOM). This product was produced commercially from farm-frozen broiler mortalities. Six replicates of five dietary treatments were assigned to Petersime battery units at 10 birds/cage. Broilers were raised to 42d on a two-feed program. Starter diets (0-21d) had DPM levels added to reduce SBOM levels from 36% to 27, 18, 9 and 0% of the diet. Grower feeds (21-42d) had DPM added to reduce SBOM to 24, 18, 12, 6 or 0% of the diet. Live production performance was evaluated at 21 and 42 days of age. No differences were detected in body weight across treatment groups, although birds fed DPM in total replacement of SBOM showed numerically reduced body weights of 49g at 21d and 89g at 42d. Similar non-significant trends were seen in feed intake, with no relationship to diet noted in 21d (1.35) or 42d (1.73) feed conversion efficiency. No differences were recorded between treatments for mortality. Use of this product in broiler feeds did not increase mortality or unduly influence weight gain or feed conversion at levels that might be used in the field.

Key Words: Dehydrated Poultry Meal, Broilers, Farm Mortality Disposal

1348 Biological evaluation of a phosphorus source prepared with a new process on broiler chicks. H. Motallebi¹, M. Masoumi Esfahani*², and A. Faghijnasirj³, ¹University of Mazandaran, ²Telavang Co., ³Deputy of Livestock Affairs.

This experiment was conducted to evaluate the quality of a phosphorous source produced from a phosphate rock. The phosphate rock obtained from Yard Asfordy mine in Iran and converted to dicalcium phosphate by using the direct process method. The process consisted of three main steps including: a) digestion, b) deflourination, and c) neutralization of the phosphorous rock. In a randomized design experiment the produced P was fed to a total of 450 day-old mixed sex broiler chicks up to 21 day of age. Meanwhile, a commercial dicalcium phosphate (DCP) was used as control and the performances of the 6 dietary treatments were compared among each of three replicates. Experimental diets contained adequate levels of all nutrients except for P. The basal control diet contained about .23 % available P and the same amount of Ca. The experimental diets were supplemented either with the standard source of DCP to provide P levels of 85, 90, 95, 100 % or with the new DCP at

two levels of 85 and 100 % of the recommended levels by NRC (1994). Calcium content of the diets was kept constant at about .9% during the experimental period. Biological value and relative biological value of P source and performance of broiler chicks was determined at 21-day age. Data reported here shows that the broilers performance was not significantly different ($P>0.05$) among the two P sources tested. Likewise, the results of this experiment showed that the new P source was both desirable and more economical during the testing period. Although, reduction of P up to 15 % below the recommended NRC (1994) level had no significant effect on broiler performance ($P<0.05$).

Key Words: Broiler, Phosphorous, Dicalcium Phosphate

1349 Organ and body growth in full-fed and paired-fed chickens consuming raw and heated velvet beans (*Mucuna pruriens*). L. B. Carew^{*1}, J. Weis¹, A. G. Gernat², F. A. Alster¹, and E. I. Zakrzewska¹, ¹University of Vermont, Burlington, VT/USA, ²Escuela Agricola Panamericana, Tegucigalpa, Honduras.

The velvet bean plant (*Mucuna pruriens*) is used widely in tropical regions as a green manure cover crop. The beans harvested from this crop are used in both animal and human diets. We showed previously that feeding the raw, untreated beans to chickens causes changes in the growth of certain organs. The objective of this study was to determine if dry heating of the beans alters these effects. Triplicate groups of seven male broiler chicks were fed the control diet or diets containing 20% raw (RVB) or heated (HVB) velvet beans from 1-24 days of age in a completely randomized design. Beans were analyzed for nutrient content and substituted into a commercial-type broiler diet at the expense of corn and soybean oil meal. Essential amino acid content was almost identical among all diets. Groups of control chicks were pair-fed with chicks fed the velvet beans by using the same amount of control diet on a daily basis. Data were considered significant at $p\leq 0.05$. At 24 days, chicks were euthanized and heart, liver, pancreas, gizzard and proventriculus weighed. Lengths of small and large intestines and ceca were also measured. Feeding RVB but not HVB caused a reduction in body weight (-8%); feed intake was 9% less although not significant. Chicks fed RVB were smaller than pair-fed and free-fed controls. Weights of pancreas, gizzard and proventriculus relative to body weight were heavier as was cecal length in chicks fed RVB. However, their size was smaller in chicks fed HVB but larger than in full-fed controls. Pair feeding did not account for these differences. Small and large intestines were relatively longer in chicks fed RVB but not different from those fed HVB. Relative weights of liver, heart and thyroid were not significantly affected by feeding either RVB or HVB. We conclude that intake of RVB has marked effects on the growth of certain organs, and in some cases this is modified by heating the beans. This suggests that RVB contain a growth factor that is altered by heat. Heating may have reduced the weight of the pancreas due to destruction of the trypsin inhibitor present in RVB. Where heating of the beans was ineffective in altering organ growth, as with lengths of the small and large intestines, the effect may be due to the increased presence of fiber.

Key Words: Velvet bean, Intestinal length, Organ weight

1350 Effect of moisture, polyamines, and iron concentration on the nutritional value of biosolids harvested from poultry processing effluent. D.V. Maurice, S.F. Lightsey*, Zulfan, D. Wicker, and J.E. Toler¹, Department of Animal & Veterinary Sciences, ¹Department of Experimental Statistics, Clemson University, Clemson, SC 29634-0361.

Three experiments were conducted to determine the effect of moisture content, polyamines, and iron content of the protein fraction of biosolids (PFBS) on broiler performance and health. High moisture (30%) and low moisture (8%) PFBS were included in corn-soy diets at 0-10% and 0-5% respectively. Inclusion of high-moisture PFBS severely depressed growth, increased mortality, decreased plasma and hepatic vitamin E, and increased erythrocyte fragility and hepatic iron but treatment effects were not detected in bone ash, organ weights, and hepatic zinc and copper. The use of low-moisture PFBS in chick diets had no adverse effects and differences were not detected in tissue elemental profile and serum glycoprotein. The effect of polyamines was evaluated in a 2 x 2 factorial experiment with PFBS included at 0 and 5% and with and without a cocktail of polyamines (4.8, 49, 197, and 131 mg/kg of phenylethylamine, putrescine, cadaverine, and histamine respectively). Neither a diet x polyamine interaction nor treatment effect was detected

in growth, feed efficiency, organ weights, condition of the gastrointestinal tract, and inflammation. The response to iron was ascertained by inclusion of low-Fe (0.6%) and high-Fe (2.42%) PFBS at 0, 2 and 4% on a nutrient basis in practical corn-soy diets to market age. Birds fed diets with the low-Fe PFBS were slightly heavier and ate more feed ($p<0.05$) than birds fed diets with high-Fe PFBS. Significant treatment effects were not detected in hepatic vitamin E, plasma ascorbic acid, abdominal fat, and organ weights. The results clearly indicated that moisture content is the major determinant of the nutritional value of heat-treated PFBS. Neither polyamines nor iron content of the PFBS induced adverse biochemical effects that impacted performance. The small advantage in favor of the low-Fe meal may be ascribed to its higher fat content.

Key Words: DAF Sludge, Biosolids, Chickens, Polyamines, Iron, Vitamin E

1351 Utilization of spent hen meal in diets for laying hens. C. A. Fritts*, J. A. Kersey, and P. W. Waldroup, University of Arkansas.

Hens at the end of their laying cycle were processed at three conventional rendering facilities to produce a high-protein spent hen meal (SHM). Meals were analyzed for nutrient content and amino acid digestibility determined using cecectomized cockerels. Diets were formulated to digestible amino acid (DAA) requirements using 0, 5, 10, and 15% of each meal. The DAA requirements were set at a minimum of 95% of the total amino acid requirements for hens consuming 100 g/day (NRC, 1994). This resulted in a total of ten dietary treatments (0 control, 3 levels of SHM x 3 locations). Each diet was fed to six groups of 12 individually caged hens (Hyline W-36) for 84 d beginning at 26 wk of age. At the end of each 28 d period eggs were weighed and shell thickness determined. Hen-day egg production, feed consumption, and mortality were determined for each 28 d period. Compared to the group with 0% SHM, the inclusion of up to 15% SHM had no significant effect on daily feed intake, feed consumed per dozen eggs, Haugh units, or eggshell thickness. Rate of egg production and egg weight declined when SHM from one of the three sources increased above 5% of the diet. However, it was difficult to ascertain the reason for the reduced performance of hens fed this source of SHM. Results of the study indicate that SHM is an acceptable ingredient for use in layer feeds but more information is needed regarding potential factors that may inhibit production.

Key Words: Spent hens, High protein meal, Laying hens

1352 Nutritive and economic values of High Oil Corn in laying hen diets. D. J. Kim and B. D. Lee*, Chungnam National University, Daejeon, South Korea.

A layer feeding trial was conducted in Korea for 15 wks to demonstrate the nutritive and economic values of high oil corn (HOC). A corn-soybean meal based commercial diet was chosen as the control diet. The yellow dent corn in the control diet was replaced with HOC to give an iso-caloric diet, or replaced with HOC on 1:1 basis to give a high energy diet. A total of 510 23-wk-old ISA Brown layers were allotted to the 3 dietary treatments with 5 replicates per treatment. In order to measure the ME values of typical corn and HOC, two metabolism trials were carried out with layers and adult roosters. The HOC used in this trial contained approximately 94% higher crude fat (6.60% as-fed basis) compared to typical corns. The GE, AMEN, and TME values of HOC are 5.7-7.7% higher than those of typical corns, indicating that the energy utilization of each corn were similar. HOC feeding, on an iso-calorie basis or on 1:1 replacement with typical corn, did not exert any effect on various laying performances, including the physical quality of egg. This reflects the quality of the commercial diet chosen as the control diet, which was already fairly good, such that the performance was already maximal. The polyunsaturated fatty acid content in yolk from hens fed HOC were higher than that from hens fed typical corn. If used alone replacing typical corn completely in a layer diet, the acceptance price of HOC was estimated to be 154 won/kg when the price of typical corn was 131 won/kg (118:100). When both corns were allowed to be used, the acceptance price of HOC increased up to 184 won/kg (140:100), indicating that a lot cheaper diet can be formulated when both HOC and typical corn are used in laying hen diet formulation.

Key Words: High Oil Corn, Laying Hen, Economic Value

1353 Effect of treated ervil (*Vicia ervilia*) diets on the performance of laying hens. M. T. Farran*, W. S. Halaby, F. T. Sleiman, M. G. Uwayjan, and V. M. Ashkarian, *American University of Beirut, Beirut, Lebanon*.

Two experiments were conducted to study the effect of water and acetic acid (AA) soaked ervil seeds in layer diets on the performance and egg quality parameters. In one experiment, ground ervil seeds, soaked in water (10:1, vol/wt) at 40 C for 72 h with water change every 12 h, and in 1% AA at room temperature (RT) and at 40 C for 24 h, and dried at RT. Isocaloric and isonitrogenous diets containing 60% raw or treated ervil were fed to 100 individually caged SCWL Layers of similar age, body weight, and production rate for a period of 42 d. Birds fed the untreated ervil had the highest BW loss and least feed intake and egg production rate. All ervil diets resulted in a significantly lower feed intake, egg production, and BW and in higher feed conversion rate, compared to the control. Hens fed the treated ervil seed diets, produced eggs with significantly higher Haugh Unit score and poorer shell thickness compared to control. Yolk color scores of treated ervil diets except for RTAA were lower than those of the control. In another experiment, diets containing 0, 10, 20, and 30% ervil seeds soaked at 40 C in 1% AA, and 30% raw ervil seeds were fed to hens for 56 d. Performance and egg quality parameters of birds fed all levels of treated ervil seeds were comparable to those of the control. A level as high as 30% of acetic acid treated ervil seeds can be used in layer diets.

Key Words: *Vicia ervilia*, Acetic acid soaking, Laying hens

1354 The effect of Eggshell 49TM and mussel shell on performance and eggshell quality of laying hens. Ruedi Hadorn¹, Hans Wiedmer¹, and Peter Spring*², ¹*Swiss Poultry Husbandry School, Zollikofen, Switzerland*, ²*Swiss College for Agriculture, Zollikofen, Switzerland*.

The aim of the present study was to evaluate the effect of Eggshell 49 and mussel shell on eggshell quality and performance of laying hens during the late phase of production. The trial was setup as a 2x2 factorial design with Eggshell 49 (0 and 1 kg/t) and mussel shell (no access and offered *ad libitum* during the afternoon) as experimental factors. The 20-week trial was conducted with 10 groups of White Lohmann Leghorn hens (176 hens per group). Hens were 49 weeks of age at the beginning of the trial. Hens were housed during their entire production cycle in floor pens. Each pen (23 m²) was equipped with a family nest box for egg laying. Feed (crumbles) and water were provided *ad libitum* in round feeders and on nipple drinkers, respectively. Birds received two different feeds (phase 1: 49-60 wks of age; 11.9 MJ UE, 18.0% CP, 3.75% Ca), phase 2: 61-68 wks of age; 11.6 MJ UE, 16.5% CP, 3.90% Ca) with nutrient contents meeting Swiss commercial diets. Egg production and mortality were determined daily. Egg classification was conducted once per laying period (28 d) while egg weight distribution was determined twice per laying period. In week 49, 58, and 66 thirty eggs per treatment were analyzed for specific weight, shell thickness and eggshell quality. Data were analyzed as a 2 x 2 factorial design with Eggshell 49 and mussel shell as experimental factors. Average egg production over the entire trial period was 86.1% and average daily feed intake was 136.0 g. Both egg production and feed intake were not affected by treatment. However, mortality over the entire trial period was significantly (P<0.05) reduced by the addition of Eggshell 49 (3.2 vs. 1.8%). Dietary supplementation with Eggshell 49 led to a change in egg size distribution. The percentage of regular size eggs (53-65g) was increased by 5%-points (38.6 vs. 43.6 %) and the proportion of large eggs (>65g) was decreased by 5 %-points (61.3 vs. 56.3 %) with Eggshell 49 supplementation (P<0.05). Eggshell quality and percentage of cracked eggs were not affected by treatment. In the present study *ad libitum* access to mussel shell had no effect on performance and eggshell quality in laying hens. However, Eggshell 49 changed egg size distribution and significantly reduced hen mortality.

Key Words: Eggshell 49, Mussel shell, Mortality

1355 High oleic acid corn in turkey diets: carcass composition and parts yield of market tom turkeys. T. Ergul*¹, P.B. Addis¹, J. Brannon¹, M.L. Endres², and S.L. Noll¹, ¹*University of Minnesota, St. Paul, MN/USA*, ²*Mycogen Seeds, Inc., Eagan, MN/USA*.

Male market turkeys (Large White, Nicholas strain) were evaluated to determine the effect of feeding high oleic acid corn (HOAC) on carcass

composition and parts yield. Poults (450) were randomly assigned to 45 pens at day of age and fed one of five different dietary treatments (TRT) varying in source of corn to 20 wks of age. TRT 1 (Control) diets contained a conventional corn hybrid. TRTs 2, 3, 4 and 5 had 25, 50, 75 and 100% of the control corn replaced with HOAC, respectively. Diets were isocaloric and formulated based on NRC (1994) requirements. The experimental design was a randomized complete block design. Birds were weighed individually at 20 wks, and one turkey per pen (nearest the mean pen weight) was selected for carcass measurements. Live body weight, carcass weight (RTC without neck), parts yield weight and percentage of carcass parts (boneless and skinless breast, drums, thighs, wings, rack) were obtained. The carcass was ground once through a 3/4-inch diameter sieve and twice with a 3/16-inch diameter sieve. Homogenous samples were taken and freeze dried. Proximate analyses were conducted (DM, CP, gross energy, crude fat, ash). No significant differences were detected among the five TRTs for live weight, carcass weight and parts weight. Breast meat yield (% of carcass weight) was significantly affected by TRT (P < 0.05), with TRT 5 having a greater yield in comparison to other TRTs. Carcass composition test results indicated that percentage CP, fat, DM and amount of gross energy were not influenced by TRT. Inclusion of HOAC corn significantly (P < 0.05) lowered ash content of carcasses from turkeys fed TRTs 2 and 4 compared with Control. Inclusion of HOAC in place of normal corn in isocaloric and isonitrogenous diets produced equivalent carcass composition except for ash and carcass yield and also equivalent carcass yield except for breast meat in market tom turkeys.

Key Words: Turkey, Corn, Composition

1356 Evaluation of chachafruto (*erythrina edulis*) foliage meal as a source of protein in laying diets for Japanese quails. H Collazos* and L.E. Davila, *Universidad Nacional Abierta y a Distancia, UNAD, Departamento de Zootecnia*.

Chachafruto is a legume native to the Interandean valleys from Venezuela to Bolivia. It is a multipurpose tree valuable in subsistence and sustainable agriculture. An 8 week trial was designed to determine the influence of chachafruto foliage meal and its influence to laying quail performance, egg yields, and egg shell quality. 128 8 week-old Japanese laying quails were allotted in a completely randomized design with four treatments (0, 10, 20, and 30% of chachafruto foliage meal), four replicates and 8 birds per replicate. Birds were reared in a quad/deck cage in an environmentally controlled house. Diets were formulated to meet or exceed NRC recommendations. Water and feed were provided *ad libitum*. Feed intake, egg weight, specific gravity, egg shell thickness, egg shell breaking strength and egg shell percentage were not affected by treatment (P>0.05). Egg production percentage and feed conversion (kg/dz) were affected by treatment (P<0.05). Haugh units were significantly improved (P<0.05) by the higher rate of supplementation.

Key Words: Chachafruto, Quail, Haugh Units

1357 Cholecalciferol, 25-hydroxycholecalciferol and vitamin C for laying hens during the initial phase of the cycle of lay. Douglas Faria*¹, Daniely Salvador¹, Monica Mazalli¹, Samir Correa¹, and Diogo Ito, *Faculdade de Zootecnia e Engenharia de Alimentos, Pirassununga, SP, Brasil*.

An experiment was conducted to evaluate the influence of two sources of vitamin D (cholecalciferol and 25-hydroxycholecalciferol) at three levels of vitamin C (0, 100 and 200 ppm) on performance and internal and external egg quality characteristics. Total blood calcium and ionic calcium concentrations were determined. The basal level of cholecalciferol was 2,756 IU/kg corresponding to 5.51 g of Hy.D[®] per ton of feed, as the source of 25-hydroxycholecalciferol. Two hundred and eighty eight Isa Babcock B-300 commercial laying hens 23 weeks of age were used during the 12-week study. A 2 x 3 factorial arrangement with eight replicates of six hens each was utilized. Feed intake, egg production, egg weight and egg mass were not influenced by treatments. An interaction (P≤.01) was observed for improved feed conversion when vitamin C was not added and 25-hydroxycholecalciferol was fed. Haugh units and yolk index were not altered but interactions were verified for improved albumen percent (P≤.01) and yolk percent (P≤.05) with 200 ppm of vitamin C. Eggshell percent, total and ionic calcium were not modified by the factors studied. It was concluded that, for laying hens during the initial phase of the cycle of lay, feed conversion could be improved by

using 25-hydroxycholecalciferol and that the inclusion of vitamin C was not beneficial.

Key Words: Ascorbic acid, Cholecalciferol, 25-hydroxycholecalciferol

1358 Effect of formulation density and feed moisture type additives on feed manufacturing and pellet quality. J.S. Moritz*, K.J. Wilson, K.R. Cramer, R.S. Beyer, L.J. McKinney, and W.B. Cavalcanti, *Kansas State University, Manhattan, KS.*

Moisture addition to corn soybean-based diets at the mixer has been shown to increase pellet durability, decrease pellet mill energy consumption and improve adjusted broiler performance. These results were directly related to moisture addition being the sole treatment difference. Moisture added at the mixer can result in a diluted nutrient profile for diets originally formulated to NRC specifications. Diets of diluted nutrient profiles are not economically practical for feeding poultry. The primary objective of the current study was to clarify the relationship between moisture addition and formulation density and how the two factors influence the feed manufacturing process. A secondary objective was to compare different types of moisture additives for potential use in broiler feeds. Treatments consisted of different moisture type additives (water/surfactant solution vs. water) and formulations of different nutrient densities (NRC density vs. adjusted -high density). Negative control treatments, which consisted of the two diets of different nutrient densities without moisture additives were also produced. Each of the six treatments were applied to four 1,000 lb (454 kg) replicate batches. Improved pellet quality, defined as increased pellet durability ($P = 0.0001$) and decreased fines ($P = 0.001$), was established for both NRC and adjusted -high density formulations when moisture additives of either type were applied. Adjusted -high density treatments that included moisture had slightly higher yet statistically similar pellet quality parameters compared to the NRC negative control treatment. Pellet mill production rates were increased for adjusted -high density treatments compared to NRC treatments, although differences were not statistically significant. These results conclude that adjusted -high density broiler diets may increase pellet mill production rates, and with the addition of moisture maintain similar pellet quality compared to NRC diets.

Key Words: Feed Manufacturing, Diet Density, Moisture

1359 Influence of expander conditioning and feed form on broiler performance. K. J. Wilson, K. R. Cramer*, J. S. Moritz, W. B. Cavalcanti, and R. S. Beyer, *Kansas State University.*

The objective of the following two experiments was to evaluate the effects of expander conditioning and feed form on broiler performance in the starter phase. The treatments consisted of an unprocessed mash which served as a negative control, and 5 treatments conditioned at 180° F (82° C) but at different expander cone pressure levels. The expander cone pressure levels included 0, 100, 200, 300, and 400 lbs/in² (0, 7, 14, 21, 28 kg/cm²). The 6 treatments were used in both experiments. The expansion conditioning was performed using a Amandus Kahl model OE 15.2 annular gap expander and pellets were produced using a CPM pellet mill equipped with a 5/32-inch x 1 1/4-inch (4mm x 32mm) pellet die. The pellets were crumbled using a roll gap width of 2.2 mm. The chicks were housed in grower cages during both of the experiments. The diet was a standard NRC corn-soy starter ration. In experiment 1 all of the diets were reground and fed as a fine ground mash. This was performed to test for a potential nutritional effect due to the expansion process and to eliminate the confounding effect of feed form. The feed was reground using a Prater Pulverizer hammermill equipped with a 1/8-inch (3.18 mm) screen. The 6 treatments were fed to 10 replicate pens containing 10 chicks (day-old) in each pen. Broilers fed the unprocessed mash treatment had higher weight gain ($P=0.0001$), feed intake ($P=0.0227$), and improved feed efficiency ($P=0.0499$) compared to all of the thermally processed diets. In experiment 2 the crumbles were screened using a Tyler number 12 sieve (1.41 mm openings) in order to remove the fines. The screened crumbles and mash control was fed to 7 replicate pens with 10 chicks (day-old) in each pen. Broiler weight gain increased linearly ($P=0.0075$) and feed efficiency was improved ($P=0.0001$) as the level of

expander cone pressure increased. Based on the results of these experiments changes in broiler performance appear to be due to the effect of feed form.

Key Words: Feed Form, Expander Conditioning, Crumbles

1360 Effect of increasing level of fines in a crumbled starter diet on broiler performance. K. J. Wilson*, J. S. Moritz, K. R. Cramer, R. S. Beyer, and W. B. Cavalcanti, *Kansas State University.*

Fines are feed particulates, which do not remain in a bonded pellet or crumble form. There are a number of factors that can influence the amount of fines generated during and following the feed manufacturing process. In past research increasing levels of fines in pelleted diets has negatively influenced broiler performance. The majority of this research has been conducted during the grower and finisher phases when diets are fed in the pellet form. The objective of this experiment was to determine the level of fines at which broiler performance would be negatively influenced when fed a crumbled starter diet. Crumbles were manufactured from pellets of high durability. A conditioning temperature of 180° F (82° C) and expander cone pressure level of 200 lbs/in² (14 kg/cm²) was used for the pelleting process. The expansion conditioning was performed using a Amandus Kahl model OE 15.2 annular gap expander and pellets were produced using a CPM pellet mill equipped with a 5/32-inch x 1 1/4-inch (4mm x 32mm) pellet die. The pellets were crumbled using a roll gap width of 2.2 mm. The crumbles were then screened using a Tyler number 12 sieve that had openings of 1.41 mm. The fines were produced by grinding pellets through a Prater Pulverizer hammermill that was equipped with a 3/32-inch (2.38 mm) screen. The pellets used for the production of the crumbles and fines were from the same source. The fines were then mixed with the sifted crumbles in order to have 0, 25, 50, 75, and 100 percent fines inclusion. The fines and crumbles were combined together using a Hobart mixer with a mix time of 30 seconds and at the lowest speed setting. The 5 treatments were fed to 7 replicate pens containing 10 chicks (day-old) per pen. The chicks were housed in grower cages during this experiment. The diet was a standard NRC corn-soy starter ration. Broiler weight gain, feed intake, and feed efficiency were negatively influenced by increasing levels of fines (Linear, $P=0.0001$). Based on the results of this experiment a level of fines exceeding 25 percent can negatively affect broiler performance in the starter phase.

Key Words: Crumbles, Fines, Broiler Starter Phase

1361 Impact of increasing levels of expander cone pressure on feed manufacturing characteristics of a broiler starter ration. K. J. Wilson*, L. J. McKinney, K. R. Cramer, J. S. Moritz, W. B. Cavalcanti, R. S. Beyer, and K. C. Behnke, *Kansas State University.*

The objective of this experiment was to evaluate how increasing levels of expander cone pressure impacts the feed manufacturing characteristics of a broiler starter ration. The feed milling characteristics that served as the response criteria included pellet and crumble durability, pellet and crumble bulk density and specific electrical energy consumption for both the annular gap expander and pellet mill. This experiment was arranged as a randomized complete block design with treatment processing order as the blocking criterion. Five levels of expander cone pressure consisting of 0, 100, 200, 300, and 400 lbs/in² (0, 7, 14, 21, and 28 kg/cm²) were evaluated in this experiment. Each of the five treatments was replicated three times. A conditioning temperature of 180° F (82° C) was used for all treatments. The expansion conditioning was performed using an Amandus Kahl model OE 15.2 annular gap expander and pellets were produced using a CPM pellet mill equipped with a 5/32-inch x 1 1/4-inch (4mm x 32mm) pellet die. The pellets were crumbled using a roll gap width of 2.2 mm. The diet was a standard NRC corn-soy starter ration. Raising the expander cone pressure level improved both pellet ($P=0.0001$) and crumble durability ($P=0.0031$). Pellet ($P=0.0150$) and crumble ($P=0.0217$) bulk density improved as the level of expander cone pressure increased. There was a linear ($P=0.0001$) increase in specific electrical energy consumption for the expander as cone pressure level increased. There was a linear ($P=0.0001$) decrease in energy required to pellet the broiler ration as expander cone pressure level increased. Based on the results of this experiment the pellet and crumble durability can be improved by increasing the level of pressure applied to the feed via the annular gap expander. The crumble and pellet bulk densities can

also be improved by increasing the level of cone pressure. A reduction in the energy required to pellet feed was obtained by raising the expander cone pressure, however total electrical energy usage increased with each corresponding rise in cone pressure level. To economically justify using an expander the benefits must offset the higher capital and operational expenses.

Key Words: Crumble Durability, Expander Cone Pressure, Pellet Durability

1362 Effect of crumble quality on broiler performance. K. J. Wilson*, R. S. Beyer, J. S. Moritz, K. R. Cramer, W. B. Cavalcanti, L. J. McKinney, and K. C. Behnke, *Kansas State University*.

In a previous feed manufacturing experiment crumble durability was improved by increasing the level of expander cone pressure. Crumble durability is one method used to define the physical quality of the crumbled feed. The objective of the following two experiments was to determine the effect of crumble quality on broiler performance. The diet used in these experiments was a standard NRC corn-soy starter ration. The treatments consisted of an unprocessed mash which served as a negative control, and 5 treatments conditioned at 180° F (82° C) but at different expander cone pressure levels. The 6 treatments were used in both experiments. The expander cone pressure levels included 0, 100, 200, 300, and 400 lbs/in² (0, 7, 14, 21, 28 kg/cm²). The expansion conditioning was performed using an Amandus Kahl model OE 15.2 annular gap expander and pellets were produced using a CPM pellet mill equipped with a 5/32-inch x 1 1/4-inch (4mm x 32mm) pellet die. The durability of the pellets improved from 27.43 percent up to 87.76 percent as the expander cone pressure level increased. The fines were not separated from the pellets prior to crumbling. The pellets were crumbled using a roll gap width of 2.2 mm. A durability test was conducted to provide descriptive information related to the quality of the crumbles. The crumble durability values were improved by increasing the expander cone pressure level indicating an improvement in crumble quality. In both experiments the six treatments were fed to 5 replicate floor pens containing 40 chicks (day-old) per pen. Feeding mash compared to the thermally processed treatments resulted in inferior (P<0.05) weight gain and feed efficiency in both experiments. Within the thermally processed treatments there were slight differences (P<0.05) in broiler weight gain for experiment 1 but not for experiment 2. Feed efficiency improved in both experiments as the level of cone pressure increased (P<0.05) and was most likely due to improvements in crumble quality. Based on the results of these two experiments broiler performance may be influenced by crumble quality. The initial durability of the pellets plays a direct role in determining the quality of the crumbles.

Key Words: Crumble Quality, Pellet Durability, Expander

1363 Effect of *Aspergillus* sp and bacterial phytase containing broiler diets on body weight, gastrointestinal transit time and the crop and cecum pH of the broiler chick. G Nava*¹, N Ledesma¹, A Priego², C Priego², L Sutton³, and G Tellez¹, ¹Departamento de Produccion Animal: Aves, Facultad de Medicina Veterinaria y Zootecnia, UNAM-Mxico, ²Productos Quimicos-Agropecuarios S.A. de C.V. Mexico, ³PetAg Inc, Hampshire, IL 60140 USA..

Both enzyme (bacterial phytase) and prebiotic (*Aspergillus* sp) have been used to improve broiler performance but the specific mechanism of action is not well known. A trial was conducted to determine the effects of adding 0.2% prebiotic, 0.04% enzyme and the combination on body weight (BW), gastrointestinal transit time (GTT) and pH changes in crop and cecum of the broiler chick. This experiment employed a completely randomized design. All of the sorghum plus soybean (S/S) diets were isocaloric and isonitrogenous and consisted of four diets with two replicates of 30 birds each (n = 240). The four experimental diets were: 1).Control S/S diet; 2).Control plus prebiotic; 3).Control plus enzyme; and 4).Control plus prebiotic and enzyme. On days 1, 9, 16 and 27, ten chicks from each diet were weighed. GTT was evaluated on days 15 and 26 using ten chicks from each diet. Crop and cecal content pH were performed on days 10 and 20 using ten chicks from each diet. There were no significant differences (P>0.05) between diets for body weight. The dietary effect was not significant for the GTT measurements at day 15 (results: 135.20^a, 168.60^a, 152.40^a and 152.20^a minutes for diet one through four, respectively). The dietary effect upon GTT at day 26

was significantly longer (P<0.05) for the prebiotic diet (results: 161.9^b, 193.20^a, 187.20^{ab} and 178.80^{ab} minutes for diet one through four, respectively). The cecum pHs were modified (P<0.05) at days 10 by the enzyme diet and the prebiotic diets (results: 6.06^a, 5.79^{ab}, 5.40^b and 5.82^{ab} pH units for diet one through four, respectively). The prebiotic and enzyme may function as a bacterial substrate that modify the intestinal microflora resulting in changes in the intestinal physiology and bacterial metabolite production.

Key Words: Prebiotic, Enzyme, Transit

1364 Effect of *Aspergillus* sp and bacterial phytase containing broiler diets on intestinal villi size and blood chemistries of the broiler chick. G Nava*¹, N Ledesma¹, A Priego², C Priego², L Sutton³, and G Tellez¹, ¹Departamento de Produccion Animal: Aves, Facultad de Medicina Veterinaria y Zootecnia, UNAM-Mxico, ²Productos Quimicos-Agropecuarios S.A. de C.V. Mexico, ³PetAg Inc, Hampshire, IL 60140 USA..

The addition of enzyme (bacterial phytase) and prebiotic (*Aspergillus* sp) to the broiler chick diet improve gastrointestinal microbial activity causing an increase of fatty volatile acid (VFA). The increase of VFA has been related to the nutrient absorption process. A trial was conducted to determine the effects of adding 0.2% prebiotic, 0.04% enzyme and the combination on the intestinal villi size and blood chemistries of the broiler chick. This experiment employed a completely randomized design. All of the sorghum plus soybean (S/S) diets were isocaloric and isonitrogenous and consisted of four diets with two replicates of 30 birds each (n=240). The four experimental diets were: 1)Control S/S diet; 2)Control plus prebiotic; 3)Control plus enzyme; and 4)Control plus prebiotic and enzyme. On day 10 and 20, ten serum samples per experimental diet were analyzed for glucose, calcium, phosphorus and alkaline phosphatase. From the same chicks samples of the ileum and cecum were fixed in 10% formaline and subsequently microscopically evaluated for morphological changes. There were no significant dietary effects (P>0.05) on the blood parameters analyzed. The intestinal villi size of the ileum and cecum of the 10 day-old broiler chick demonstrated no dietary effect (P>0.05). The intestinal villi size of the ileum of the 20 day-old broiler chick demonstrated significant dietary effect (P<0.05) due to the prebiotic addition (results: 392.4^b, 768.0^a, 505.^b 2 and 411.6^b microns for diet one through four, respectively). There were no significant dietary differences (P>0.05) in the length of the cecum villi in the 20 day-old chick (results: 233.40^a, 249.60^a, 199.20^a and 233.40^a microns for diet one through four, respectively). The prebiotic supplementation in neonatal broiler chick diets may improve the intestinal microflora activity and bacterial metabolite production (VFA) as related to the increase of 20 day-old ileum villi length.

Key Words: Apergillus meal, Phytase, Ileum villi

1365 Effect of phytase, organic trace minerals and age at photostimulation on performance of brown eggshell laying hens. T. Ao*, N. D. Paton, A. H. Cantor, A. J. Pescatore, M. J. Ford, and C. A. Smith, *University of Kentucky*.

The effects of supplementing a low-phosphorus basal diet with phytase (Alltech, Nicholasville, KY) and organic forms of Mn, Zn and Cu (ES49) (Eggshell 49, Alltech) and of age of pullets at photostimulation on egg production variables were studied. Using a commercial strain of laying hens (Hy-Line) producing brown shelled eggs, 18 replicate groups of 12 hens, housed two per cage, were assigned to each of four dietary treatments. Hens were housed and subjected to photostimulation at 15, 16 or 17 wk of age. The basal diet was fed alone or supplemented with phytase (11,500 ptu/kg diet) or ES49 (providing 4.5 mg Mn, 7.5 mg Zn and 1 mg Cu per kg diet as proteinates) in a factorial arrangement. Calculated nutrient values of the basal diet were: 2900 kcal AME/kg, 16.6% CP, 0.47% Met, 3.75% Ca and 0.17% available P. A trace mineral supplement used in all diets provided 51 mg Mn, 60 mg Zn and 8 mg Cu per kg diet as inorganic salts. Production variables were measured during a 52-wk period, starting at 17 wk of age. Feed intake during the 52-wk period was unaffected by diet, but responded linearly (P < 0.05) to age at housing. Hens housed at 15, 16 and 17 wk of age consumed 104, 105 and 107 g/hen/d, respectively. Hen-day egg production for the 52-wk period (mean = 81.5%) was unaffected by both age at housing and diet. Housing at 17 wk (*vs.* 15 and 16 wk) increased average egg weight (61.6 g *vs.* 60.5 and 60.4 g) but decreased average per cent shell

(8.93% vs. 9.18 and 9.12%). Phytase significantly increased the breaking strength of the humerus, but not the tibia, measured after 45 wk of production. These results indicate that early photostimulation decreases egg weight and feed intake and increases per cent shell, and that the levels of available P, Mn, Zn and Cu in the basal diet are adequate to support layer performance. However, the increased humerus breaking strength due to phytase suggests that the level of P was marginal for maintaining bone strength.

Key Words: Phosphorus, Phytase, Photostimulation

1366 Sources and levels of total phosphorus in the diet of broilers from 2 to 28 days of age. L. F. Araujo*¹, O. M. Junqueira¹, D. Mucke², R. Knoop², and C. S. S. Araujo¹, ¹Universidade Estadual Paulista - UNESP/Jaboticabal - Brazil, ²Burge Fertilizantes S/A - Sao Paulo - Brazil.

One experiment was conducted to evaluate the performance of broilers receiving various sources and levels of phosphorus from 2 to 28 days of age. Four hundred chickens, 2 days of age, were distributed in a 4 x 2 factorial design (4 sources of phosphates - fine dicalcium phosphate (FDP); granulate dicalcium phosphate (GDP); a mixture of dicalcium phosphate + sodium (DPS); defluorinated phosphate (DFP) and two total phosphorus levels - 0.60% and 0.70%) with 8 treatments and 5 replications of 10 birds each. At the end of the experiment, two birds of each pen were slaughtered to obtain the tibia bone for phosphorus, calcium, magnesium and fluorine. There were no interactions between the treatments. The best weight gain and feed conversion were found in the birds receiving the diet containing GDP in the presence of 0.70% total phosphorus. The worst weight gains and poorest feed conversions were from birds fed the diet with DPS and 0.70% total phosphorus. The highest feed intakes were from diets containing GDP and 0.70% total phosphorus. There was no difference in the tibia calcium, phosphorus and magnesium between studied treatments. However, broilers fed the diets containing DPS and DFP showed, respectively, higher and lower tibia fluorine. According the results obtained, it is concluded that the best performance was from broilers fed diet with GDP and the level of 0.70% total phosphorus. The tibia fluoride level was lower in DFP diets. Acknowledgements: Burge Fertilizantes S/A Brazil for technical support.

Key Words: Phosphorus Sources, Phosphorus Levels, Tibia Minerals

ASAS/ADSA Animal Health

1368 *In vitro* aflatoxin binding characteristics of an esterified glucomannan product. J.W. Evans* and M. Kudupojje, *Alltech Biotechnology Inc., Nicholasville, KY.*

Mycotoxin binders have been shown to reduce the deleterious effects of aflatoxin in animals. A series of experiments were conducted to examine the binding characteristics of an esterified glucomannan (EGM) derived from the yeast cell wall of *Saccharomyces cerevisiae*. The EGM has been shown to reduce the toxic effects of aflatoxin in livestock. In the first study, an *in vitro* binding assay was used to determine the saturation point of aflatoxin binding by EGM in water or phosphate buffer. The binder (0.1%) was mixed with increasing concentrations of toxin (2,4,6,8 and 10 ppm in water/18, 20, 22, 24 and 26 ppm in buffer), centrifuged and unbound toxin concentrations were determined in the supernatant. The saturation point was defined as the minimum binder concentration at which maximum binding is reached. The saturation point for aflatoxin binding was greater in phosphate buffer than in water (8 vs. 24 ppm). In addition, aflatoxin binding responded to phosphate concentrations in a quadratic fashion ($P < 0.001$). Another trial was conducted to determine binding strength in water and phosphate buffer. Aflatoxin (1 ppm) and EGM (0.1%) were mixed, incubated at 37°C for 1 h, and centrifuged. Toxin concentrations were determined in the supernatant and pellet after three methanol extractions. Binding was stronger in the phosphate buffer than in water as indicated by lower aflatoxin recovery in the buffer (568 vs. 279 ppb, $P < 0.001$). A third study compared the saturation points of the EGM and a clay binder (CB). Both binders were mixed in water with increasing toxin concentrations until saturation was reached. The binding capacity of EGM in water was more than four times higher than CB (5.2 vs. 1.2

1367 Total phosphorus (TP) requirements of meat chickens from 3 to 7 weeks of age. A. Abudabos*, D. V. Maurice, S. F. Lightsey, and W. C. Bridges, Jr.¹, *Animal & Veterinary Sciences, ¹Department of Experimental Statistics, Clemson University, Clemson, SC.*

We previously reported that dietary phytate P is utilized and TP could be decreased without impairment in productivity and substantial reduction in P excretion. However, the variation in body weight between birds on the same treatment prompted us to examine the response of birds, sorted by weight, to dietary TP. The aim of this experiment was to determine the effect of dietary TP in birds sorted into 2 groups: heavy (H) and light (L) at 3 wk. of age; then each group received 4 different diets. Corn-soybean diets were formulated, based on assayed TP values checked with standard reference materials, to contain 0.5, 0.55, 0.6 and 0.65% TP from 3-6 weeks and 0.38, 0.55, 0.6, and 0.65% TP from 6-7 weeks of age. Each diet was fed to 3 pens of each weight group. We measured the effects of TP, gender, and weight groups on growth, breast muscle yield, serum P, bone ash and measures of bone integrity, and intestinal phytase activity. Interactions were not detected and neither dietary TP or weight group had a significant effect on feed intake, body weight gain, feed conversion, breast muscle yield, and intestinal phytase at 6 weeks. Serum P was decreased in birds fed 0.5 % TP when compared to those fed the other three diets ($P < 0.001$). The responses at 7 weeks were similar to those observed at 6 weeks except that gender and weight group effects were detected. Serum P was a function of the amount of inorganic P in the diet ($P < 0.0001$). Phytase activity was dramatically affected by diet ($P < 0.02$); birds that received the 0.38% TP diet (no inorganic supplement) had the highest activity. Bone ash decreased ($P < 0.0001$) as dietary TP was lowered but femoral and tibial length, weight, cross-sectional area, polar moment of inertia, and area moment of inertia were not affected by diet. The results show that dietary P can be lowered from 3 to 7 weeks without loss in performance and reduction in mechanical properties of long bones.

Key Words: Dietary Phosphorus, Intestinal Phytase, Growth, Bone Integrity

$\mu\text{g}/\text{mg}$ binder, $P < 0.001$). This series of studies showed that EGM is able to bind aflatoxin and not mask or destroy it. In addition, aflatoxin binding by EGM is phosphate dependent and more efficient at binding aflatoxin than binding by the CB tested.

Key Words: *In vitro* binding, Aflatoxin, Esterified glucomannans

1369 Growth and immune function of calves fed milk replacer with added nitrate. S. T. Franklin, R. O'Carra, R. J. Harmon, D. M. Amaral-Phillips, and J. A. Jackson, *University of Kentucky, Lexington, KY.*

A concentration of 10 - 20 ppm nitrate-N in water is considered a health risk for humans and may cause methemoglobinemia. Little is known, however, of the effects of nitrate-N on health and immune function of neonatal dairy calves. Thus, 24 calves (4 Jersey and 20 Holstein; male = 12 and female = 12) were assigned to treatments of 0, 10, 20, or 40 ppm nitrate-N (as potassium nitrate) added to reconstituted milk replacer. Calves were moved to individual calf hutches and assigned to treatments at an average of approximately 5 d of age. Milk replacer (20% protein and 20% fat) was reconstituted in water to provide 0.45 kg of solids daily and fed in two equal feedings. Nitrate-N was added to reconstituted milk replacer at each feeding. Milk replacer intake was recorded at each feeding and starter consumption was determined daily. At 5 wk of age, milk replacer was fed once daily and calves were weaned at 6 wk of age. Calves were weighed when moved to hutches and weekly thereafter. Blood samples were obtained at 2 wk intervals for total white blood cell counts, neutrophil function assays, and proliferation assays. There was no effect ($P > 0.05$) of nitrate-N addition to milk replacer on

body weights of calves, total white blood cell counts, ingestion or killing of *Staphylococcus aureus*, or proliferation of mononuclear leukocytes in response to mitogen stimulation. Both ingestion and killing of *Staphylococcus aureus* decreased ($P < 0.01$) over the 6 wk study. For wk 0, ingestion of *S. aureus* averaged 11.5 bacteria per neutrophil and for wk 6 averaged 8.4 bacteria per neutrophil. Killing for wk 0 averaged 34% of added bacteria compared to 23% for wk 6. Ingestion and killing also were lower ($P < 0.01$) for winter versus spring calves. Ingestion of *S. aureus* averaged 10.8 bacteria per neutrophil for winter calves and 9.1 bacteria per neutrophil for spring calves. Similarly, killing averaged 33% of added bacteria by neutrophils from winter calves compared to 26% killing of added bacteria by neutrophils from spring calves. In conclusion, nitrate-N at concentrations up to 40 ppm in milk replacer did not greatly affect growth or immune function of neonatal calves, however, neutrophil function decreased as calves aged and was lower in spring compared to winter.

Key Words: Nitrate, Calves, Immune function

1370 Brain cholinesterase activity in cattle exposed to coumaphos in Mexico. V. Pardo^{*1}, N. Ibarra¹, A. Velasquez², B. Nochebuena¹, E. De la Cruz¹, and J. Alfaro¹, ¹Universidad Veracruzana, Veracruz, Veracruz/Mexico, ²Instituto Mexicano del Seguro Social, Veracruz, Veracruz/Mexico.

The purpose of the study was to determine Cholinesterase (ChEs) activity values from brain stem of cattle to evaluate the exposure to organophosphate pesticides, since the intensive use of these pesticides in Mexico represents a potential danger to livestock and to human health. Four groups of ten animals from different areas were sampled. Brain stems from mature male adults *Bos taurus* x *Bos indicus* 18 months of age were collected at the Federal Inspection slaughter in Veracruz, Mexico. Brain stem was removed according to official Mexican procedure and placed into cold buffered isotonic solution. Brain stem was sectioned into protuberance, medulla oblongata and the cervical region of spinal cord. ChE activity determination was according to Ellman method and AchE was assayed with iso-OMPA. Cholinesterase activities were expressed as UI/mL. Results were analyzed by ANOVA with Minitab 10.5. The mean AchE activity in medulla oblongata section of the animals dipped in coumaphos at the recommended dose every 21 days during 3 months was significantly lower than a group of animals not treated with any pesticide from the farm of the Faculty of Veterinary Medicine, but not statistically different from the other groups analyzed. The mean ChE and AchE activities in medulla oblongata and spinal cord of a group of animals dipped in coumaphos at the recommended dose every 21 days during 6 months were significantly lower than a group of animals not treated with any pesticide and than the group of animals dipped during 3 months. The mean AchE activities in medulla oblongata and spinal cord of the group of animals sprayed with coumaphos at the recommended dose twice a month during 6 months were significantly lower than the group of animals not treated with any pesticide and than the group dipped during 3 months. Among the three sections of tissue analyzed, medulla oblongata mean AchE activity was statistically higher than the AchE activities of the protuberance and spinal cord. Results indicate that medulla oblongata of cattle represents a useful area for measurement ChE activity for laboratory screening as an aid in diagnosing anticholinesterase insecticides exposure in cattle.

Key Words: Organophosphate pesticides, cholinesterase activity, brain stem

1371 Extension needs and approaches towards livestock health improvement in Bangladesh : Proshika experience. Nuru Miah, *Proshika Manobik Unnayan Kendra, Bangladesh.*

Livestock contributes 6.5% percent of the GDP and 13% of the agricultural GDP in Bangladesh. The livestock sector has been trapped in low productivity levels due to inadequate extension coverage of the Govt. sector. Proshika, one of the largest Non Govt. Development Organisations in Bangladesh has been operating livestock extension and support services in its working areas. It provides livestock extension services to cattle and poultry farmers through well trained resource persons. About 60 to 100 vaccinators, 10 to 15 paravets, 4 to 6 A.I. technicians, and 4-6 feed sellers in each upzilla are engaged in providing vaccination, deworming, treatment, artificial insemination services, and suppling quality feeds to rearers of cattle and poultry. Veterinary drug pharmacies are operated by advanced paravets. These extension agents

are selected from proshika group members, trained for particular skills, provided equipment boxes with equipment's, and are allocated to working areas to maintain strong links to producers. Vaccines not produced locally are imported by Proshika and supplied to the beneficiaries. Fees are collected from cattle and poultry owners for their livelihood. These extension activities have reduced poultry mortality from 20 percent to 5 to 7 percent; cattle mortality has been reduced from 10 to 15 percent to 3-4 percent. These efforts have significantly increased the livestock and poultry population. Farmers undertaking different livestock rearing projects have increased their income up to 150 percent. The monthly net income of vaccinators, paravets and A.I. technicians varies from US Dollar 15 to 45 based on the activity. These extension approaches contribute towards the increased productivity of livestock resources, enhancement of gender equity and equality, and ensure participation of vulnerable women in productive enterprises.

Key Words: Paravet, Deworming, Extension

1372 Bedding material preferences of crossbred cattle. DilipKumar Garikipati^{*1}, Kailash M. M.², and Sarjan Rao Kapa¹, ¹College of Veterinary Sciences, Tirupati, ²Bangalore Agricultural University.

Twenty crossbred HF cattle were examined for preferences in bedding materials. Two experiments were done. In experiment 1, crossbred cattle (n=10) were housed individually with access to 3 free stalls, each with different bedding material: Paddy straw, sawdust, or deep-bedded sand. After access to all 3 materials for 10 days, preference was determined by stall use and lying times, recorded for 24 h by videotape recorder. Each animal was then restricted to either sand or paddy straw for period of one week. Average lying time, and numbers of transitions between standing and lying, were significantly ($p < 0.05$) less than when animals were restricted to sand or paddy straw. After the restriction phase, animals were again allowed access to all 3 bedding types and final preference was determined. Nine of 10 animals continued to choose sawdust. In experiment 2, 10 more animals were tested with sawdust, sand (both as described above), and paddy straw and waste paper materials. Initial & final preference tests as described above showed that 8 of 10 cows preferred sawdust. In the middle stage of the experiment all animals were restricted to each bedding material, in turn, for 5 days. Average lying time, time spent in the stall, and transition to lying were significantly ($P < 0.02$) lower for the sand - bedded stalls but there was no differences between other 2 surfaces. These results indicate that (1) cows prefer deep bedded sawdust, (2) that lying time, time spent in the stall, and number of lying transitions are affected when cows are provided with sand and paddy straw, but not with paddy straw covered with waste paper material.

Key Words: cow comfort, behavior, well-being

1373 Economic Efficacy of Treatment Protocols for Clinical Mastitis. E.H. Shim^{*}, R.D. Shanks, and D.E. Morin, *University of Illinois, Urbana.*

The objective was to quantify the costs associated with two treatment protocols and the differences between the use of supportive therapy alone versus antibiotics in addition to supportive therapy. Between January 1994 and December 1995, 116,876 daily milk (DM) records on 676 lactations were taken at the University of Illinois Dairy Unit. Mastitis was diagnosed during 124 lactations with 25,047 DM records. Based on examination, each cow with clinical mastitis was assigned a severity score of 1 (least severe) to 3 (most severe) and randomly assigned to one of two treatment groups: N (supportive treatment only) and A (antibiotics in addition to supportive treatment). Extent of antibiotic and supportive treatment varied according to protocols. A treatment cost analysis was calculated for all lactations with at least one case of mastitis. Predicted and actual DM yields were estimated utilizing a random regression-test day model. The differences between the predicted and actual DM were summed for all 305 days of lactation to estimate milk loss for each mastitic lactation. Lactations that utilized antibiotics in addition to supportive therapy incurred \$21 per lactation more in average treatment costs than lactations utilizing supportive therapy alone. Cows treated with supportive therapy alone lost 1,530 kg more marketable milk per lactation than cows treated with both antibiotics and supportive therapy. The addition of antibiotics to supportive therapy reduced the total economic loss by \$382 per treated lactation. Based on smaller milk yield and economic losses, the efficacy of antibiotics

in addition to supportive therapy was greater than supportive therapy alone.

	A	N
Average number of days with clinical mastitis	13	22
Average treatment cost	\$49	\$28
Average 305-day milk yield loss (kg)	182	1809
Milk loss due to unmarketable or unproduced milk (kg)	513	2043
Cost of lost milk*	\$135	\$538
Total cost (cost of lost milk and treatment)*	\$184	\$566

*based on the February class 1 mover milk price of \$0.2632 per kg

Key Words: Mastitis, Economics, Antibiotics

1374 Effect of Left Displacement of Abomasum (LDA) Corrected by Toggle Pin Suture on Performance of Holstein Dairy Cows. J.E.P. Santos¹, E. Raizman^{*1}, L.G. Corbellini², and R.A. Cerri¹, ¹University of California, Davis, ²Universidade Federal do Rio Grande do Sul.

Objectives were to evaluate the effects of left displacement of abomasum (LDA) corrected by toggle pin suture on performance of lactating Holstein cows. Cows calving between June 1997 and February 2000 (374; 188 LDA and 186 controls) from a commercial dairy farm in central California were followed during the first 320 days in milk (DIM). Cows were diagnosed with LDA by the herd veterinarian and treated by the herd personnel by rolling the cow over her back and tacking the abomasum with toggles introduced after trocar punctures. Every LDA cow was matched with a herdmate that calved within 14 d of the affected cow's calving date, was in the same lactation and had a similar 305-d mature equivalent (ME) milk yield in the previous lactation (300 kg). Only cows that stayed in the herd for more than 60 DIM were included in the analyses. Continuous variables were analyzed by ANOVA and binomial data by Chi-square. Cows affected with LDA produced less milk (33.3 vs 31.6 kg/d; $P < .01$) and 3.5% FCM (33.2 vs 32.0 kg/d; $P < .06$), and had a lower 305-d ME milk yield (12,563 vs 12,073 kg; $P < .05$). However, milk fat yield (1.16 vs 1.13 kg/d; $P < .22$) and linear SCC (2.68 vs 2.86; $P < .24$) were similar, and milk fat content tended to be higher for cows with LDA compared with controls (3.51 vs 3.60; $P < .08$). Cows with LDA had a prolonged period from calving to first AI (77.9 vs 92.8; $P < .001$), but first AI conception rate, percentage of cows pregnant by 150 and 320 DIM were unaffected by LDA. Mean days open for pregnant and for all cows were unaffected by LDA, as well as the incidence of abortion and mastitis. Days in milk at the first clinical mastitis case tended to be lower for cows with LDA (140.7 vs 94.0; $P < .12$). Nevertheless, more LDA cows died (1.1 vs 8.0%; $P < .001$) or were sold (9.1 vs 27.7%; $P < .001$) by the end of the study. In addition, LDA cows left the herd (dead or sold) earlier in lactation (230.2 vs 102.1 DIM; $P < .001$). In conclusion, cows affected with LDA produced less milk, but most of the lactation losses were caused by increased death and culling early in lactation.

Key Words: Left displacement of abomasum, Dairy cows, Lactation

1375 Effect of disease on fertility traits in Swedish dairy cattle using survival analysis methodology. D.O. Maizon^{*1,2} and P.A. Oltenacu¹, ¹Department of Animal Science, Cornell University, ²Facultad de Ciencias Veterinarias, Universidad de Buenos Aires.

Fertility traits are economically important in dairy cattle herds. In this study, the effect of disease on days from calving to conception was estimated. A sample of 20% of all cows that calved in Swedish farms in 1991 was used. The final data set was restricted to cows in their second or greater lactation with at least one service after calving, and consisted of 18,114 Ayrshire (SRB), and 12,530 Friesian (SLB) cows. Since days from calving to conception is a time-to-event variable, and about 26% are censored records in each breed, the analyses were performed using the Survival Kit software. A Weibull model was assumed, each breed was analyzed separately, and assessments were based on the likelihood ratio test. The models included the following confounders: season of calving, length of previous dry period, herd size, and average fat corrected milk of herd and cow, all treated as classificatory variables. The diseases studied were dystocia (DYST), milk fever (MKFV), and retained placenta (REPL) as time-independent covariates, and cystic ovaries (CYST), metritis (METR), other reproductive diseases (OTRE), mastitis (MAST), ketosis (KETS), feet and leg disorders (FFET), and

other diseases (OTHE) as time-dependent covariates. The diseases with negative and statistically significant ($p < 0.05$) effects on days from calving to conception were RTPL, CYST, and MAST in SRB cows, and DYST, OTRE, METR, MAST, and OTHE in SLB cows. The corresponding risk ratios, statistically different from one ($p < 0.05$), for these diseases were 0.785, 0.893, and 0.876 in SRB cows, and 0.638, 0.669, 0.742, 0.871, and 0.82 in SLB cows, respectively. These risk ratios indicate that these diseases decrease the probability of conception, and increase the time-to-conception.

Key Words: Dairy Cattle, Diseases and Fertility, Survival Analysis

1376 The diagnostic value of serum cholesterol in cows and newborn calves. R. Skrzypek^{*}, Agricultural University of Poznan, Poland.

The study was conducted on 210 cow-calf pairs of crosses between native Black-and-White cattle and Holsteins. Cows were sampled 7-8 weeks before expected parturition, and 12-14 hours after parturition. Calves were sampled at the age of 24 hours, and 5 days after birth. There was found no significant relationship between the course of the parturition period (normal delivery, dystocia, placenta retention, and milk fever), and concentration of serum total cholesterol (TCh) in cows, as well as in their calves. In cows, serum TCh concentration tested before parturition was correlated negatively with the number of insemination services per confirmed pregnancy, and length of calving interval ($r \sim -0.2$; $P \leq 0.05$). Before parturition, cows with the shortest calving interval (≤ 365 days) compared to cows with the longest calving interval ($401 \leq$ days) had significantly higher serum TCh concentration by 0.20 mmol/L ($P \leq 0.05$). After parturition, the highest serum TCh concentration was found in the group of cows with medium length of calving interval (366-400 days). In calves that were afflicted with diarrhoea or died during the first month after birth, at both samplings it was found significantly lower serum TCh concentration (range from 0.10 mmol/L; $P \leq 0.05$ to 0.19 mmol/L; $P \leq 0.01$), as compared to control calves. It is concluded, that serum total cholesterol concentration is associated positively with reproductive performance of cows, as well as health and survival of the newborn calves.

Key Words: Cattle, Serum cholesterol, Diagnostic value

1377 Development of a DNA-based vaccine for the prevention of staphylococcal mastitis. E.W. Carter^{*} and D.E. Kerr, University of Vermont, Burlington VT.

Staphylococcus aureus often results in a chronic infection of dairy cows. Current vaccine formulations are often ineffective in preventing infection. The objective of this study was to stimulate an immune response in dairy cows through injection of plasmid DNA containing a staphylococcal Protein A gene. To determine the most effective method of DNA-based vaccination of cows, intramuscular and intradermal vaccination sites were evaluated using a plasmid containing the jelly-fish Green Fluorescent Protein (GFP) gene. DNA was delivered by needle and syringe, or by high or low-pressure jet injection. For each injection site, 15 animals, six weeks prepartum, were assigned to receive DNA by one of the three delivery techniques. On each of three days, at two week intervals, each animal was given three injections (0.17 ml) containing a total of 0.5 mg of plasmid in 0.15 M saline. Serum samples were collected at two week intervals for anti-GFP antibody analysis by ELISA. Antibody titers (1/100 dilution) peaked approximately two weeks after the final injection. It was found that intradermal high-pressure jet-injection elicited the best response (3 of 4 animals responding). In contrast, needle and syringe delivery was ineffective while response to low pressure injection was intermediate. Similar results developed from intramuscular injection. A Protein A expression plasmid was constructed with an 827bp fragment of the Protein A gene inserted downstream of the CMV promoter region in the pcDNA3 vector. Protein A expression by eukaryotic cells was evaluated by transfection of COS-7 cells followed by Western blot analysis. The results confirmed the expression of the expected 32 kD Protein A. This plasmid is currently being evaluated as a vaccine in cows using high-pressure jet-injection. Specific humoral (ELISA) and cell mediated (lymphocyte proliferation assay) immune responses will be monitored. We have shown that an antibody response to a foreign antigen can be raised in dairy cows using a DNA-based vaccine. The needle and syringe delivery method was not as effective as jet injection

1378 Immunogenicity of a putative intranasal vaccine against bovine respiratory syncytial virus (BRSV) in calves. B. Earley^{*1}, O. Kavanagh², B. Adair², and R. Fallon¹, ¹Teagasc, Grange Research Centre, Dunsany, Co. Meath, Ireland., ²Veterinary Science Division, Stormont, The Queen's University of Belfast, BT4 3SD, Northern Ireland.

The objective of the study was to evaluate the effects of microencapsulated synthetic peptides of bovine respiratory syncytial virus (BRSV), following intranasal administration, on the cellular and humoral immune responses of calves. F peptide (F111-148)(0.5mg) and G peptide (G174-187)(0.5mg) representing known protective epitopes against BRSV were microencapsulated. Fifty-two Holstein/Friesian calves, approximately 56 days of age, were allocated randomly to one of the following 4 treatments (13 per treatment); 1). Soluble F-peptide (SF) and soluble G-peptide (SG) in phosphate buffer saline (PBS); 2). Microencapsulated poly(lactide-co-glycolide (PLG)-peptide-F and PLG-peptide-G); 3). Microencapsulated coupled to ovalbumin (OVA) (PLG OVA-peptide-G and PLG OVA-peptide-F); 4). Phosphate buffered saline control. Interferon (IFN) gamma production in response to concanavalin-A (Con-A) was determined in cultured lymphocytes on days 28 and 142 post-primary inoculation. Serum immunoglobulins (Ig) were measured quantitatively by single radial immunodiffusion on day 28 post-inoculation. The data were analysed using analysis of variance procedure and if a significant difference was observed, Duncan's multiple range F-test was applied to determine statistical differences between treatments. There was no difference ($P > 0.05$) between treatments in response to Con-A induced IFN gamma-production from lymphocytes cultured on days 28 or 142 indicating that the vaccination had no effect on the cellular immune response. There was no significant difference in serum Ig concentrations between treatments ($P > 0.05$). A sustained antigen-specific IgA response was induced in the calves nasal mucosa and lungs by all treatments ($P < 0.05$) when compared with PBS control calves on day 28 for the SF and SG peptides. On Day 77 post-primary inoculation the antigen-specific IgA response to the F peptide subunit was maintained in all treatments compared with control while the response of the G peptide subunit ($P > 0.05$) was not sustained. Non-live subunit vaccines encapsulated in biodegradable microparticles are a novel approach to achieving a protective immune response against specific pathogens in the hosts' respiratory tract.

Key Words: Bovine Respiratory Syncytial Virus, Microencapsulation, Immune Function

1379 Differential tyrosine phosphorylation on bovine PMN. Kynita Campbell¹, Max Paape², Mulumebet Worku^{*1}, and Yan Wang², ¹North Carolina Agricultural and Technical State University, ²USDA Beltsville, Maryland.

Protein tyrosine phosphorylation is a key step in pathogen destruction by neutrophils (PMN) following ligand receptor interaction. Bovine blood PMN were isolated by differential centrifugation and hypotonic lysis of red blood cells. Viability was assessed by Trypan blue dye exclusion, purity by differential cell counts and concentration using a Coulter counter. Isolated PMN (10^7) were treated with *Escherichia coli* lipopolysaccharide (LPS)(1,000ng/ml, 100ng/ml), Dexamethasone (0.25mg/ml, 0.15mg/ml) and Sodium Butyrate (160 μ M, 80 μ M) or maintained in buffer (1 hour, 37°C). Cells were then lysed with Laemmli buffer, boiled, sonicated and analyzed by SDS-PAGE. Tyrosine phosphorylation was detected by western blotting with a mouse anti-phosphotyrosine monoclonal antibody and alkaline phosphatase conjugated goat anti-mouse antibody using BCIP-NBT substrate (Kirkegaard and Perry Laboratories). The number and intensity of phosphorylated protein bands after treatment were compared to untreated PMN. Lysates from untreated PMN contained six distinct bands. LPS and Dexamethasone treatments resulted in dephosphorylation of all bands. One unique band remained phosphorylated after treatment with Sodium butyrate. Dexamethasone (0.25mg/ml) resulted in the appearance of a unique band (64KDa). These proteins may play a significant role in modulation of bovine PMN function.

Key Words: Polymorphonuclear (PMN), Protein phosphorylation

1380 Bovine PMN release the COX-2 protein when stimulated with bacterial lipopolysaccharide. Jenora Waterman and Mulumebet Worku^{*}, North Carolina Agricultural and Technical State University.

Neutrophils (PMN) are central to the inflammatory response of mammals. Cyclooxygenase-2 (COX-2) is one of two isoforms of the enzyme that catalyzes the production of prostaglandins from arachidonic acid. We show here that bovine PMN release the COX-2 enzyme when stimulated with *Escherichia coli* lipopolysaccharide (LPS). Bovine blood PMN from the caudal vein were isolated by differential centrifugation and hypotonic lysis of red blood cells. Viability was determined by Trypan blue dye exclusion, purity by differential cell counts and concentration using a hemocytometer. Isolated viable PMN (10^7) were incubated for 0.5, 1, 1.5, 2, 2.5, and 3 hours in the presence or absence of 10 ng/ml LPS. Cells were harvested, lysed and fractionated using 12% SDS-PAGE. COX-2 was identified by western blot analysis and enhanced chemiluminescence. COX-2 is expressed by bovine PMN. Expression of COX-2 can be modulated by treatment with LPS. Thus, bovine PMN may actively influence the eicosanoid composition during inflammation.

Key Words: Cyclooxygenase-2, PMN

1381 Modulation of apoptosis in bovine blood PMN by actinomycin-D, lipopolysaccharide, and sodium butyrate. P Matterson^{*}, S Knight, and M Worku, NC Agricultural and Technical State University.

The longevity of neutrophils (PMN) is critical to cell function and resolution of inflammation. The development of methods to assess apoptosis in bovine PMN is essential to development of new therapies to control inflammations such as mastitis. Here we describe a modified assay to detect apoptosis in bovine PMN by comparing the effect of actinomycin-D (160 μ M), sodium butyrate (160 μ M), *E. Coli* lipopolysaccharide (LPS)(10ng/ml) treatments versus untreated isolate of PMN. Whole blood was collected from healthy, lactating Holstein cows (N=3) in 15ml vacutainer blood collection tubes pretreated with 250 IU of heparin sodium. The blood was pooled, diluted with 1X PBS, separated by gentle centrifugation and RBC were lysed with 0.83% ammonium chloride several times until a white pellet and clear supernatant was obtained. Viable, isolated PMN were verified by microscopic observation and counting, using Trypan Blue exclusion for viability (98.0%) and Wright stain differentials. Treated and control PMN were spotted onto poly-L-Lysine, subbed slides. After drying, slides were then assayed for apoptosis detection using Promega's Apoptosis Detection Kit which is based on the TUNEL method of labeling fragmented DNA of apoptotic cells with Fluorescein. The percentage of cells incorporating green fluorescence was evaluated microscopically. Actinomycin-D induced apoptosis (37%) while LPS only tended to induce apoptosis (19%). Sodium butyrate maintained (12%) PMN longevity compared to control cells (13%). Although cow to cow variation was observed, this method was effective in determining the effect of modulators of inflammation on bovine PMN.

Key Words: apoptosis, neutrophil, mastitis

1382 Techniques for RNA isolation and cDNA integrity in bovine blood PMN. S Knight^{*}, M Worku, P Matterson, and S Dance, NC Agricultural and Technical State University Greensboro, NC USA.

Obtaining full-length quality cDNA is critical to experiments involving RNA analysis and library construction. This is even more so in neutrophils. Studies were conducted to evaluate two methods of RNA isolation and a cDNA integrity kit developed by Kirkegaard and Perry Laboratories, for determination of quality cDNA in the human, mouse, and rat systems. Bovine neutrophils (PMN) were isolated by differential centrifugation and hypotonic lysis of red blood cells. Viability was assessed by Trypan blue dye exclusion, concentration was determined by hemacytometer counts and purity by Wright's stained smears. Two methods of RNA isolation (Tri-Reagent and RNAzol) were compared and RNA quality determined by electrophoresis. To determine cDNA integrity, RNA was isolated from viable PMN using Tri-Reagent and a denaturing MOPS/formaldehyde agarose gradient gel. The RNA was reverse transcribed and the cDNA amplified by PCR using six primers specific for regions of the 3' and 5' ends of the housekeeping gene GAPDH, two

common ribosomal protein genes, L3 and S6, and the 3' and 5' regions of the clathrin gene. Tri-Reagent produced the purest RNA preparation with minimal DNA contamination. The cDNA kit may also be applicable for determination of bovine neutrophil cDNA integrity, and identity of conserved sequences. Acknowledgement to KPL for enabling us to serve as Beta tester.

Key Words: Neutrophil, cDNA, RNA

1383 Isolation of membrane protein associated with IgM binding from bovine neutrophils. A Johnston-Ward*, S Knight, and M Worku, *NC Agricultural and Technical State University Greensboro, NC USA.*

Isolation of membrane protein Fc receptors for IgM is essential to the determination of their role in bovine neutrophil (PMN) function for the formulation of possible therapeutics against bovine mastitis. Bovine PMN from two Holtstein-Friesians were isolated by hypotonic lysis of red blood cells and centrifugation. PMN were biotinylated and lysed. The lysates were incubated with purified bovine IgM, followed by goat anti-bovine IgM antibody, and immunoprecipitated with Protein A/G sepharose beads. Proteins were detected using western blotting and enhanced chemiluminescence (ECL) following binding of horseradish peroxidase conjugation Streptavidin. Two to three proteins ranging from 30-90kDa were shown using Coomassie Blue stain. After biotinylation, six proteins of 38-90 kDa were seen using ECL detection. Following immunoprecipitation a unique protein at 28 kDa was also detected with ECL. Further analysis is needed to identify and characterize this protein and any other associated membrane proteins.

Key Words: biotinylation, IgM, Neutrophils

1384 Establishing and comparing profiles of antimicrobial resistance in *Staphylococcus aureus* isolates from selected organic and conventional dairy farms in Vermont. C. Nugent*, P. Murdough, W. Panky, and J. Barlow, *University of Vermont, Burlington, VT.*

Resistance to antimicrobial agents has become a great concern in human medicine, and has been linked to the use of antimicrobials in agriculture (Khachatourians, 1998). Antibiotics are used in agriculture both to increase growth rates in livestock as well as to treat and prevent disease. In the dairy industry, antibiotics are commonly used to combat bovine mastitis. The purpose of this study is to describe and compare the antimicrobial resistance patterns among bacterial isolates obtained from individual quarter milk samples of cows on selected dairy farms in Vermont. Bacterial isolates were collected over an 18 month period from 10 dairy farms, including 6 certified organic dairies where antibiotic use is avoided, and 4 conventional dairy farms that routinely use antibiotics for treatment and prevention of disease. In this preliminary study, the antimicrobial resistance profile of 180 *Staphylococcus aureus* isolates (54 from conventional farms and 126 from organic farms) was established by standard disk diffusion and minimum inhibitory concentration (MIC; Sensititre, Trek Diagnostics, WestLake, OH) methods. Sixteen antibiotics were evaluated. Increased proportions of isolates showing resistance to ampicillin, penicillin, pirlimycin, sulfamethizole, and tetracycline were observed from conventional dairy farms compared with organic farms. No differences in proportion of resistant isolates were observed for amoxicillin plus clavulonic acid, cephalothin, ceftiofur, enrofloxacin, erythromycin, florfenicol, gentamycin, lincomycin, neomycin, oxacillin, and penicillin plus novobiocin. Data on the prevalence of mastitis isolates (such as *Staphylococcus aureus* and *Escherichia coli*) displaying antimicrobial resistance may be used to evaluate the potential impact of current treatment practices on the development of antibiotic resistant pathogens on dairy farms.

Key Words: Antibiotic Resistance, Dairy Cattle, Mastitis

1385 Improved quantification of total lipids from liver samples. B. N. Ametaj*, Y. Lu, G. Bobe, J. W. Young, and D. C. Beitz, *Iowa State University, Ames, IA.*

Fatty liver is a major metabolic disease of dairy cows, and early diagnosis, as based upon total lipid percentage of the liver, is important for effective treatment or prevention. Previous methods for assaying total lipids in liver biopsy samples involved freezing in liquid nitrogen, pulverization of samples by percussion, extraction by shaking overnight in 2:1

chloroform and methanol (vol:vol), evaporation of solvent, and weighing of total lipids. Pulverization causes variable losses of liver sample, and utilization of liquid nitrogen is hazardous. We evaluated combinations of sonication, homogenization, and pulverization, followed by shaking for extraction of total lipids from liver samples. Results from samples obtained by biopsies of livers of dairy cows indicate that sonication is safer and faster than pulverization of liver samples. The sufficient amount of time for sonication (0, 10, 20, 30, 40, 50, and 60 sec) was 30 sec. Homogenization for 2 min and shaking overnight in chloroform:methanol (2:1 vol:vol) did not affect the amount of total lipids extracted ($P > 0.1$) compared with sonication and shaking for 2 h. From different amounts of liver sample (50, 100, 150, 200, and 250 mg), the amount of lipid extracted from at least 150 mg resulted in repeatable results ($CV < 10\%$). Our data indicate that sonication for 30 sec, shaking for 2 h, sitting overnight at 4° C, and drying samples under air for 6 h is an efficient and reproducible method for quantification of total lipids from bovine liver. (Partly supported by funds from CSREES-USDA agreement 99-35004-8576)

Key Words: Total lipids, Liver, Bovine

1386 Effect of slow-release insulin on bovine hepatic lipidosis. A. Hayirli*, J. E. Kayhart, S. J. Bertics, and R. R. Grummer, *University of Wisconsin, Madison.*

The aim of this study was to determine if there is a dose of insulin that decreases concentrations of plasma NEFA and liver TG, without compromising plasma glucose concentration. Forty Holsteins were blocked according to calving date and assigned randomly to a single IM injection of one of four doses of slow-release insulin on d 3 postpartum. Cows were allowed ad libitum consumption of the same diet from 15 d prepartum to 6 d postpartum; on d 3 postpartum, they were fed hourly to minimize fluctuations in blood metabolites due to intake pattern. Blood samples were collected every hour from 0 to 24 h and every 6 h from 24 to 48 h following injection. Pre- and post-injection liver samples were taken on d 2 and 5 postpartum, respectively. Main and polynomial effects of insulin were tested by ANCOVA using a mixed model with repeated measures. One cow receiving .29 and two cows receiving .43 IU insulin/kg BW could not complete the trial due to severe hypoglycemia and their data were excluded from analyses. Both DMI ($P < .13$) and milk yield ($P < .15$) increased quadratically by insulin injection. Plasma glucose linearly decreased ($P < .0001$), serum insulin linearly increased ($P < .0001$), and plasma NEFA quadratically decreased ($P < .05$) for 24 h following injection. On d 4 postpartum, serum insulin concentration remained higher in insulin-injected cows than in saline-injected cows ($P < .08$) and the quadratic effect of insulin on plasma NEFA continued ($P < .02$). Percent change in liver TG decreased quadratically by insulin injection ($P < .08$). The low dose of slow-release insulin could be considered for prophylactic use against hepatic lipidosis.

Response Variable	Dose ¹				SEM
	0	.14	.29	.43	
DMI, kg/d (d 3-5)	15.1	16.6	15.6	14.3	.9
Milk yield, kg/d (d 3-5)	30.1	34.7	31.9	29.3	2.3
0-24 h Insulin, μ U/ml	2.0	3.5	5.7	7.6	.7
0-24 h Glucose, mg/dl	47.5	42.3	35.9	36.7	1.7
0-24 h NEFA, μ Eq/ml	576.0	512.0	538.8	643.4	41.0
Liver TG, % DM (d 5)	9.9	8.1	11.5	11.1	1.4
Change inTG, % (d 2 vs. 5)	26.7	-10.2	12.3	42.9	18.1

¹Insulin, IU/kg BW

Key Words: Insulin, Bovine, Hepatic lipidosis

1387 Utility of RAP-PCR to identify genes in bovine liver differentially expressed following in vivo endotoxin (LPS) challenge. E. E. Connor*, C. M. Ashwell, S. Kahl, and T. H. Elsasser, *USDA-ARS, Beltsville, MD.*

The liver is a target organ of cytokine action during an immune response and is the principal site of acute phase protein synthesis. In the present study, RNA arbitrarily primed polymerase chain reaction (RAP-PCR) was used to evaluate hepatic gene expression profiles of saline and low-level LPS-treated cattle to gain novel information on gene expression in inflammatory disease. A single bolus of either saline (n = 4) or LPS (*E. coli* 055:B5, 0.2 μ g/kg, n = 6) was administered through a jugular

catheter on two occasions 5 d apart. Liver biopsy was performed on each animal 8 h after the second LPS challenge to obtain tissue for total RNA isolation and subsequent RAP-PCR analysis. RAP-PCR analysis identified six genes as differentially expressed by LPS challenge. Increases in expression of vascular cell adhesion molecule-1 ($P = 0.02$) and a bovine homolog of a novel human protein, hT41 ($P = 0.04$) were confirmed in LPS-treated livers. No differences in expression ($P > 0.05$) of the four other genes were detected by Northern analysis. Our results indicate that RAP-PCR is a useful tool for identifying novel genes expressed in cattle; however significant validation is required for accurate interpretation of results. Additional study is needed to determine the role of hT41 in the acute phase response in cattle.

Key Words: Endotoxin, RAP-PCR, Cattle

1388 **Prepartum body condition score and liver glycogen concentration decrease circulating memory activity to viral antigens in periparturient dairy cows.** D. C. Donovan^{*1}, A. R. Hippen¹, and D. J. Hurley¹, ¹*South Dakota State University, Brookings.*

The objective of the study was to correlate physiological effects associated with periparturient condition, and the related fatty liver and ketosis complex, with suppression of nonspecific responses and specific responses to viral antigens. Eight Holstein multiparous cows with a mean prepartum body condition score (PBCS) of 3.38 (range: 3.0-4.0) were utilized from a concurrent trial. Blood samples were taken weekly from 7 to 21d postpartum. T cell memory activity to bovine viral disease virus (BVDV), bovine respiratory syncytial virus (BRSV), and parainfluenza 3 (PI3) were measured in vitro. Staphylococcus aureus exotoxin B (SEB) was used as an internal standard of nonspecific lymphocyte proliferation. A negative correlation ($r = 0.42$, $P = 0.02$) was demonstrated between T cell proliferation induced by SEB in culture and PBCS. T cell memory response to BVD in culture was also strongly and negatively correlated ($r = 0.41$, $P < 0.04$) with PBCS. In contrast, T cell memory response to BRSV in culture was not correlated with PBCS, but strongly, negatively correlated ($r = 0.46$, $P = 0.07$) with liver glycogen concentration. The proliferative response to PI3 was not correlated with any of the physiological parameters measured. Nor were any of the responses correlated to liver lipid concentrations. This data suggests that gross physiological measures (prepartum body condition score) and specific indicators of physiological status (liver composition) are predictive of the capacity to mount specific and nonspecific immune responses. As such, they are indicative of increased susceptibility to infectious disease.

Key Words: Prepartum body condition, T cell memory, Virus

1389 **Impact of season and heat stress on SCC from infected and uninfected quarters.** B. A. Broadus^{*}, R. J. Harmon, R. W. Scaletti, K. Akers, B. A. Smith, S. H. Hayes, and C. H. Hamilton, *University of Kentucky, Lexington, KY.*

Infection data were obtained monthly from June, 1999 to September, 2000 at the University of Kentucky dairy. The herd was comprised of Holsteins and Jerseys, averaging 120 lactating cows per month. Quarter foremilk samples were collected for bacteriological determination and somatic cell counts (SCC). The Livestock Stress Index (LSI) estimated heat stress by using the peak mean value for the seven days prior to sample date. LSI is calculated by combination of temperature and humidity. During the sample period two different summer conditions were observed; the first summer had 20 days of temperature in excess of 35° C, but the second summer had nine days at those temperatures. The first summer was during a drought with no more than three cm of rain, compared to the second where an excess of nine cm was reported. For uninfected quarters the geometric mean SCC was 29,000 cells/ml. For infected quarters the geometric mean SCC was 207,000 cells/ml. Coagulase-negative staphylococci (CNS) infections comprised 61 percent of the total infected quarters with a geometric mean SCC of 146,000 cells/ml. *Staphylococcus aureus* infected quarters had a geometric mean SCC of 621,000 cells/ml. The relationship of SCC of infected quarters to LSI differed when comparing the two different summers. There were no significant correlations between log SCC and LSI when looking at the total sample period. However, when evaluating October, 1999 through September, 2000, significant positive correlations were found for LSI and log SCC of uninfected quarters ($P < 0.0013$), infected quarters ($P < 0.0001$), major pathogens ($P < 0.0175$), minor

pathogens ($P < 0.0004$), and CNS ($P < 0.0003$). All correlation coefficients were less than 0.12. The correlation of SCC and LSI for uninfected quarters was 0.049. The results suggest no marked changes in SCC were observed in uninfected quarters during hot summer weather. Hot summer weather may have a minor impact on SCC in infected quarters, but the effect is variable. Thus, infection status of the mammary gland, not heat stress, is the major factor determining SCC.

Key Words: Somatic Cell Count, Mastitis, Heat Stress

1390 **Relationship of somatic cell score with fertility measures.** R.H. Miller¹, J.S. Clay², and H.D. Norman^{*1}, ¹*Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD,* ²*Dairy Records Management Systems, Raleigh, NC.*

Dairy Herd Improvement data from 284,450 Holstein and Jersey cows in 37 states were examined to determine relationships of test-day somatic cell score (SCS), herd, calving year, parity, lactation stage, and calving ease score with fertility measures [rate of nonreturn to estrus by 70 d after first service, days to first service (D1), and days open (DO)]. Relationship of elevated SCS prior to first insemination with nonreturn rate was of primary interest, but factors other than SCS were examined to ensure that estimation of SCS effect was independent of other variables. Nonreturn rates differed greatly by month. Rates were highest during April and May and lowest during June (a difference of 8 to 9% for Holsteins and 12% for Jerseys). Nonreturn rate also was affected by parity (6 to 7% higher nonreturn rate for first parity than for sixth parity and later), lactation stage at first service (increase in nonreturn rate of 8 to 13% from early to late lactation), and calving ease [a 7% decline in nonreturn rate from score 1 (no birth difficulty) to score 5 (extreme birth difficulty)]. For Holsteins, linear regression of nonreturn rate on preceding test-day SCS was significant ($P 0.01$), particularly for SCS recorded within 2 to 3 wk prior to insemination; however, regression coefficients were small (0.004 to 0.005). A similar relationship was not found for Jerseys. Quadratic regression of D1 on SCS was significant for Holsteins ($P < 0.05$) and Jerseys ($P < 0.01$); linear regression of DO on SCS was significant ($P < 0.01$) for Holsteins. The magnitude of SCS effect on fertility traits does not warrant postponement of first service for cows in estrus because of elevated SCS on previous test day. However, additional emphasis on mastitis control and, consequently, a slight increase in the economic weight for SCS in genetic selection may be justified.

Key Words: Fertility, Nonreturn rate, Somatic cell score

1391 **Efficacy of a concentrated equine serum product to prevent failure of passive transfer of immunity in neonatal foals.** C.J. Hammer^{*1}, J.A. Booth¹, L. Etzel², and H.D. Tyler¹, ¹*Iowa State University, Ames, IA USA,* ²*Proliant, Ames, IA USA.*

Colostrum antibodies are the most important factor providing immunological protection to the neonatal foal. Foals that fail to obtain adequate amounts of these antibodies, those classified with failure of passive transfer, are at an increased risk for developing infection and/or death. The primary objective of this study was to determine if an orally administered concentrated equine serum product provided in the first hours of life could prevent failure of passive transfer in foals. To achieve this objective, ten foals of Quarter Horse breeding were utilized. Foals were alternately assigned to serve as a control or to receive the oral product. Treated foals were administered 250 ml of the oral serum product at 1 and 3 h of age via nasogastric intubation. These foals were muzzled to prevent nursing from their dam. Supplemental milk replacer (200 ml/feeding) was provided to the treated foals at 6 and 9 h of age. The dams of treated foals had their udder stripped at 1, 3, 6, and 9 h post parturition. The initial colostrum collected (200 ml) was fed back to the treated foals when the muzzle was removed at 12 h of age. Control foals were allowed to nurse from their dams ad libitum. Ten ml jugular blood samples were obtained from all foals (5 treated/5 control) at 1, 3, 5, 7, 9, 10, 11, 12, 24, and 48 h of age for determination of concentrations of plasma IgG. Plasma IgG concentrations were higher ($p < .05$) for treated foals compared to control foals at 5 h and 48 h of age. Plasma IgG concentrations were not different ($p > .10$) between treated and control foals at all other time periods measured. All treated foals had plasma IgG concentrations over 700 mg/dl by 10 h of age. These data suggest that administration of this concentrated oral plasma product is effective

in raising foal serum IgG concentrations and minimizing the incidence of failure of passive transfer.

Key Words: Immunoglobulin, Colostrum, Foal

1392 Heritability of *Ascaridia galli* egg output in laying hens. Matthias Gauly^{*1}, Christian Bauer², and Georg Erhardt¹, ¹*Institute of Animal Breeding and Genetics, University of Giessen*, ²*Institute of Parasitology, University of Giessen, Germany*.

Twenty week-old Lohmann LSL (n = 46) and Lohmann Brown (n = 40) laying hens were orally infected with 250 embryonated *Ascaridia galli* eggs. The hens descended from 11 different sires. During a 12 month laying period the animals were kept in battery-cages in an environmentally controlled chicken house and faecal samples were collected separately from each bird once a month (samples 1 to 12) to determine faecal egg counts (FEC). A modified McMaster technique was used. Weights of the birds were also taken at monthly intervals. A group of 15 (LSL) and 20 (Brown) control animals, kept under the same conditions, were sampled in parallel. No anthelmintic treatments were given at any time. FEC were transformed as the decimal logarithm of n (number of eggs) + 25 to correct for heterogeneity of variance and to produce normally distributed data. Statistical analysis was performed with the Statistical Package for Social Science for PC (SPSS-PC Version 9.0). The model for estimating heritabilities of log-transformed data included the father as a random effect and age as a fixed effect. All infected animals excreted *A. galli* eggs. The percentage of positive samples (FEC > 50) was 69.1 and 33.7. LSL hens had a significantly (p < 0.01) (2.38, SE: 0.04) higher mean log10 FEC compared to Lohmann Brown (1.89, SE: 0.03). There was no significant (p > 0.05) difference in laying performance between control and infected groups. The relative body weight development of the LSL chicks was significantly (p < 0.05) higher in the control group. The estimated heritabilities for mean log10 FEC were between 0.0 (all samples) and 0.10 (SE: 0.041) (samples 1-6) for Lohmann Brown and 0.13 (SE:0.039) (all samples) and 0.19 (SE:0.029) (samples 1-6) for Lohmann LSL. This opens a way of genetic selection for *A. galli* resistance in chickens, which will be of importance for birds kept in alternative and organic farming systems.

Key Words: Genetic resistance, *Ascaridia galli*, Chicken-Nematoda

1393 Antibiotic effects of Tylosin in the large intestine of swine fed sub-therapeutic concentrations of Tylan. M.D. Howard^{*1}, J.A. Zahn¹, and D.L. Harris², ¹*National Swine Research Information Center, USDA-ARS*, ²*Iowa State University*.

The objectives of this study were to: 1) measure the concentration of tylosin and bioactive tylosin metabolites in the large intestine of pigs fed a typical corn-soy finishing diet, containing a sub-therapeutic level of tylosin (20 g/907 kg of feed); 2) determine the in vitro minimum inhibitory concentration (MIC) for *Micrococcus luteus* and *Brachyspira hyodysenteriae*. Large intestinal digesta of three pigs (107.0 kg 2.0) were solvent-extracted and antibacterial compounds were isolated by coupled preparative reverse-phase liquid chromatography (P-RPLC) followed by a plate diffusion assay with *M. luteus* as the indicator microorganism. Four major bioactive fractions were purified to homogeneity by a second P-RPLC step and structures of the compounds were assigned using electrospray-ionization tandem mass spectrometry (MS-MS). The identity, concentration, and yield of bioactive compounds purified from the digesta were: Tylosin A (112.2 8.2 mg/kg, yield = 74%); tylosin D (241.6 19.3 mg/kg, yield = 81%); demycarose-tylosin A (36.0 2.3 mg/kg, yield = 78%); and demycarose-tylosin D (21.0 1.3 mg/kg, yield = 79%). The MIC of purified tylosin A for *M. luteus* was found to be 4.3 1.3 mg/kg, and the MIC for *B. hyodysenteriae* was found to be 1.1 0.4 mg/kg. The MIC of the four bioactive compounds were found to be statistically (a = 0.05) identical in MIC assays performed using *M. luteus*. Therefore, the normalized concentration of all bioactive forms of tylosin was used to estimate potential sub-therapeutic effects of tylosin on susceptible bacteria in the gut of swine. The total concentration (0.52 mg/kg) of all bioactive forms of tylosin was found to be in the MIC range of *B. hyodysenteriae* (1.0 0.6 mg/kg). This result suggests that sub-therapeutic levels of tylosin may influence microbial community structure in the gut of swine through direct antibiotic effects. Additionally, results of this study show, for the first time, the identity

and concentration of tylosin metabolites in the gut of swine that exhibit antibacterial activity.

Key Words: Tylosin, growth promotion, antibiotic resistance

1394 Adhesion of *Actinobacillus pleuropneumoniae* to swine soluble fibronectin. R.C. Hamer^{*1,2}, I. Enriquez², D. Godinez², R.Z. Martinez², P. Talamas², S. Vaca³, and M. de la Garza², ¹*FMVZ- Universidad Autonoma de Sinaloa. Culiacan, Sinaloa Mexico.*, ²*CINVESTAV-IPN. Zacatenco. Mex. D.F. Mexico.*, ³*ENEP- Iztacala. Universidad Nacional Autonoma de Mexico. Mexico.*

Actinobacillus pleuropneumoniae (Ap) is an important cause of swine respiratory disease. Adhesion to the swine respiratory tract is an initial step in infection. Fibronectin is one of the most abundant extracellular matrix proteins in lung connective tissue. The objective of this work was to show the interaction of Ap with swine soluble fibronectin. Ap cells were seen adhered to fibronectin, using negative staining by transmission electron microscopy. This interaction was observed as protein nets with bacteria adhered. Adhesion kinetic studies of Ap to swine fibronectin films was performed in microtitration plates, adhesion was observed for the first 5 min of incubation and it was maintained for 3 hours. Heat killing of bacteria inhibited adhesion almost completely; heparin or swine serum from convalescent pigs diminished adhesion in less proportion. Also, some carbohydrates and metaperiodate had an important effect on adhesion. Immunofluorescence using anti-swine fibronectin antibodies revealed bacteria adhered to fibronectin when both were in contact. These experiments revealed bacterial-protein interactions, and a possible important role of fibronectin in bacterial recognition of swine lung, colonization, and subsequent infection. Project supported by CONACyT-Mexico grant no. 28755B.

Key Words: Pneumonia, Fibronectin, Swine

1395 Testing for the Presence of Enterotoxigenic *Escherichia coli* Infections Causing Diarrhea in Swine Using PCR and ELISA Techniques. S. Cole^{*1} and R. R. Marquardt¹, ¹*University of Manitoba*.

Five strains of Enterotoxigenic *Escherichia coli* (ETEC) K88 (F4), K99 (F5), 987P (F6), F41, and F18 (F107) have been shown to cause diarrheal disease in young pigs. It is important to identify specific strains of *E. coli* by their colonization factor genes if they are to be treated with therapeutic antibodies as each antibody is specific for a given strain. Among different procedures only genetic and immunological techniques are specific. The objectives of this study were to adapt two types of assays to detect the presence of these five strains of ETEC in swine, the polymerase chain reaction (PCR) and the enzyme linked immunosorbent assay (ELISA). The polymerase chain reaction is a genetic assay applied to the testing of fecal samples from animals with diarrhea where *E. coli* is the suspected cause. PCR has been called the DNA photocopier that replicates many copies of a target DNA strand which can be used for identification of the organism. The ELISA technique can be used to test for the presence of anti-*E. coli* colonization factor antibodies in the blood of swine. The antibodies that result from an infection will persist for a matter of weeks in the animal. In this way even if no animals are sick at the time of investigation, the disease exposure of healthy animals could indicate the presence of a pathogen that has been a problem and may be again. Preliminary refinement and testing of these methods at the University of Manitoba have proven successful by indicating the presence of specific pathogenic *E. coli* strains in the feces of pigs specifically inoculated. In addition the ELISA method too has proven the ability to detect anti-*E. coli* colonization factor antibodies in the blood of pigs. The assays have proven to be fast, specific, sensitive and accurate for the application of therapeutic antibodies in an ETEC control program.

Key Words: Enterotoxigenic *E. coli*, PCR, ELISA

1396 Differential effect of dexamethasone on lymphocyte proliferation and immunoglobulin production *in vitro*. M.R. Rogers*¹, S.C. Lozano¹, K.M. Kammlah¹, T.H. Welsh, Jr.², and J.C. Laurenz¹, ¹Texas A&M University-Kingsville, ²Texas A&M University-College Station.

The present study investigated the effect of the synthetic glucocorticoid, dexamethasone (DEX), on concanavalin (ConA)-induced lymphoproliferation and immunoglobulin M (IgM) production by pig lymphocytes *in vitro*. Blood was obtained from male, crossbred pigs (n=3-6 pigs/experiment; 40-45 days of age) and lymphocytes obtained by density gradient centrifugation over Lymphoprep (Nycomed, Oslo, Norway). Lymphocytes were plated in 96-well plates at 1×10^5 cells/well in DME/F12 containing 10% fetal bovine serum, 2 mM L-glutamine, 10 uM 2-mercaptoethanol, ConA (0 to 10 ug/ml) and/or DEX (0 to 10^{-6} M). Cultures were incubated for 96 h and lymphoproliferation determined using the CellTiter proliferation assay (Promega, Madison, WI). In replicate cultures, supernatants were removed and IgM production determined using an ELISA specific for pig IgM. As expected, ConA induced a dose-dependent increase ($P < .01$) in lymphoproliferation and IgM production with maximal effects occurring at .6 and 1.25 ug/ml, respectively. Although not effecting basal lymphoproliferation, DEX dose-dependently inhibited ($P < .01$) ConA-induced (0.3 and 1.25 ug/ml) lymphoproliferation with maximal effects occurring at 1×10^{-8} M. However, the suppressive effects of DEX (1×10^{-8} M) on lymphoproliferation could be overcome ($P < .05$) with the addition of higher concentrations of ConA (5 to 10 ug/ml). Similarly, when cells were stimulated with low concentrations of ConA (.3 ug/ml), DEX dose-dependently inhibited ($P < 0.01$) IgM production with maximal effects occurring at 10^{-8} M. In contrast, in cultures treated with 1.25 ug/ml ConA, low concentrations of DEX (10^{-10} to 10^{-9} M) actually augmented ($P < .05$) IgM production. Furthermore, DEX (10^{-8} M) induced additional 1.7 to 1.9 fold increases ($P < .05$) in IgM production by lymphocyte cultures treated with higher concentrations of ConA (2.5 to 10 ug/ml, respectively). Collectively, these results demonstrate that glucocorticoids have primarily a suppressive effect on lymphocyte proliferation, but can augment immunoglobulin production depending on both the degree of lymphocyte stimulation and the concentration of glucocorticoid.

Key Words: Pigs, Glucocorticoid, Lymphocyte

1397 Effect of oral administration of dehydroepiandrosterone-sulfate (DHEAS) on pig lymphocyte function *in vitro*. S.C. Lozano*¹, T.H. Welsh, Jr.², and J.C. Laurenz¹, ¹Texas A&M University-Kingsville, ²Texas A&M University-College Station.

The present study investigated the effect of chronic, oral administration of DHEAS on lymphoproliferation and immunoglobulin (IgM) production by isolated lymphocytes *in vitro*. Crossbred, female pigs (n = 12; initial weight 9.3 .5 kg) were assigned by weight to one of two treatments (n = 6 pigs/treatment) and were fed either 0 or 1 mg DHEAS/kg body weight twice daily for 100 days. At the end of the treatment period, blood was obtained via jugular venipuncture and lymphocytes isolated by density gradient centrifugation over Lymphoprep (Nycomed, Oslo, Norway). Lymphocytes were plated in 96-well plates at 1×10^5 cells/well in DME/F12 containing 10% FBS, 2mM glutamine, 10 uM 2-mercaptoethanol, ConA (0 to 2.5 ug/ml), or ConA (.3 or 1.25 ug/ml) in the presence of DEX (0 to 10^6 M). Cultures were incubated for 96 h and lymphoproliferation determined using the Celltiter proliferation assay (Promega, Madison, WI). In replicate cultures, supernatants were removed and immunoglobulin M (IgM) production determined using an ELISA specific for pig IgM. As expected, ConA induced dose-dependent increases ($P < .01$) in lymphoproliferation and IgM production with initial increases apparent at .3 ug/ml and maximal effects occurring at 1.25ug/ml ConA. Although not effecting ($P > .05$) the response of lymphocytes to low concentrations of ConA ($< .3$ ug/ml), feeding of DHEAS to pigs increased ($P < .05$) the extent of lymphoproliferation and tended to increase ($P = .06$) IgM production by lymphocytes at higher concentrations of ConA (.6 to 2.5 ug/ml). In both treatment groups, DEX dose-dependently inhibited ($P < .01$) ConA-induced (0.3 and 1.25 ug/ml) lymphoproliferation with maximal effects occurring at 10^{-8} M. Similarly, when cells were stimulated with low concentrations of ConA (.3 ug/ml), DEX dose-dependently ($P < .01$) inhibited IgM production with maximal effects occurring at 10^{-8} M. In contrast, in cultures treated with 1.25 ug/ml ConA, DEX (10^{-10} to 10^{-8} M) augmented ($P < .05$) IgM production and the effect of glucocorticoid treatment was increased ($P < .01$) in pigs fed DHEAS. Collectively, these results indicate that oral administration of DHEAS can enhance the responsiveness of lymphocytes to antigenic challenge and suggest that DHEAS may be beneficial to enhance immune function in domestic livestock species.

Key Words: pigs, dehydroepiandrosterone, glucocorticoid

ASAS/ADSA Breeding and Genetics: Gene Mapping, QTL, and Statistical Methods

1398 A novel and highly effective method to generate transgenic mice and chickens: linker-based sperm-mediated gene transfer. Jin Qian*¹, Yi-Hsin Liu², Mason Jiang³, Tsehay Mekonnen¹, and Ken Wang¹, ¹BioAgri Corp., ²Center for Craniofacial Molecular Biology, USC, ³Dept. of Anesthesiology, UCLA.

Genetic modification of domestic animal traits can be used to improve productivity and quality or to produce bioreactors for modern medicine. DNA microinjection, the current method to produce transgenic livestock, is time consuming and requires extensive training and special equipment. More importantly, except in mice, microinjection has reported only limited success in larger or higher species. Sperm-mediated gene transfer has been recognized as a potentially powerful alternative method, but has been questioned by many laboratories around the world since the original results were difficult to duplicate. We have developed a linker (mAb C) to bind with sperm and DNA. Using flow cytometry, it has shown cross-reactivity with sperm cells from all tested species including mouse, pig, cow, sheep, goat, chicken, and human. mAb C has been characterized as a basic protein and has been shown to bind DNA through ionic interaction. We report here the use of this novel linker with the sperm-mediated gene transfer method to successfully generate transgenic mice and chickens. Sperm from FVB/N mice were treated first with mAb C and then combined with a linearized DNA fragment, pGL3-control (Promega). After *in vitro* fertilization, fertilized eggs at the two-cell stage were implanted into pseudopregnant mice. 12 offspring were born and used to mate with wild type mice. 2 (16.7%) transmitted transgenic mouse lines (F1) were identified by Southern blot. Furthermore, this novel technology was also tested in the chicken through artificial insemination. The transgene was detected in 10 out of 88 (11.4%) chicken embryos by PCR. Combined with our high success

rate in making transgenic pigs (58.3%) through surgical oviduct fertilization, our data strongly suggests that this novel linker-based sperm-mediated gene transfer method is both universal and effective and could be of great value to modern agriculture and medicine.

Key Words: Linker-based sperm-mediated gene transfer, Transgenic chicken, Transgenic mice

1399 Generation of transgenic pigs by sperm-mediated gene transfer using a linker protein (mAb C). Keejong Chang^{2,3}, Jin Qian¹, Mason Jiang⁴, Ming-Che Wu⁵, Chidar Chen², Hin-Lung Lo³, Meng-Chun Hu², Wen-Wen Lin², Iris Ho², and Ken Wang*¹, ¹BioAgri Corp., ²BioAgri Corp., Taiwan Division, ³Dept. of Chemistry, Soochow University, ⁴Dept. of Physiology, Taiwan Livestock Research Center, ⁵Dept. of Anesthesiology, UCLA.

Sperm-mediated gene transfer (SMGT) has been recognized as a potentially powerful method to make transgenic animals for many years. The current method of gene transfer, microinjection, used widely in transgenic mouse production, has had only limited success in producing transgenic animals from larger or higher species. We report here a sperm-mediated gene transfer method that uses a linker protein to vastly improve the efficiency of large transgenic animal production. A monoclonal antibody (mAb C) that could be used as a linker was identified after screening hybridomas immunized with mouse sperm cells. mAb C is reactive to a surface antigen on mouse sperm cells and is also cross-reactive with sperm cells from many different species such as pig, cow, sheep, goat, chicken, and human. mAb C has been characterized

as a basic protein that binds to DNA through ionic interaction. Therefore exogenous DNA can specifically bind to the sperm surface via mAb C and has been shown to successfully integrate into the chromosome of mouse, pig and chicken offspring. Furthermore, expressed foreign proteins can be detected in the serum of transgenic pigs. Diluted pig sperm cells were mixed with mAb C to form a sperm-mAb complex and then pSEAP-2 reporter gene DNA (Clontech) was added to react with the sperm-mAb complex. In group I and II animals, one half-million treated sperm cells were injected into each side of the oviduct in ovulating pigs by surgical oviduct fertilization. In group I, forty-three pig offspring (F0 founders) were analyzed and 30.2% (13/43) of piglets' tails were shown to contain exogenous DNA integration into the host genome by Southern blot analysis. 58.3% (21/36) of these offspring were found to express SEAP secreted into the serum. In group II, thirty-two pig offspring (F0 founders) were analyzed. Results of Southern blot and SEAP analysis show similar findings as those in group I. In a subsequent study, seventeen F0 founders were randomly selected to mate with wild type pigs. Seven (41.2%) transmitted transgenic lines (F1 generation) were identified by Southern blot analysis. These results demonstrate that transgenic pigs can be generated with a remarkably improved efficiency by sperm-mediated gene transfer using the linker protein, mAb C.

Key Words: Linker-based sperm-mediated gene transfer, Transgenic pigs

1400 Macroarray analyses of differential gene expression in porcine fetal and postnatal skeletal muscle RNA. S. Zhao*^{1,3}, C. Fitzsimmons¹, C. Ernst², and C. Tuggle¹, ¹Iowa State University, Ames, IA, ²Michigan State University, East Lansing, MI, ³Huanzhong Agricultural University, Wuhan, PRC.

High-throughput analysis of transcript abundance holds great promise to identify genes controlling biological traits important in animal agriculture. To test the utility of such transcriptional profiling for porcine muscle gene expression studies, a cDNA macroarray comprising 327 cDNAs spotted in duplicate onto nylon membrane filters was developed. Total RNA from two muscle samples, 75-day fetal hind limb muscles (including gluteus, semitendinosus and semimembranosus) and 7-week postnatal semitendinosus muscle, were used to make radiolabeled targets for filter hybridization. To test reproducibility, two identical membranes were hybridized to each target in two separate incubations. The intensity of expression at each spot was determined by phosphor imager scanning and evaluated by ImageQuant software. Values for each probe spot were normalized to signal at the beta-actin probe spot and to signal from a complex probe consisting of a mixture of cDNA from spleen, muscle, liver and lung tissues. Correlation coefficients of signal intensity between duplicate spots was greater than 0.98 and normalized signal intensity between two identical membranes was greater than 0.96 (Pearson test), indicating the reproducibility between duplicate spots and identical membranes was very good. Differences in gene expression between the two developmental stages for each gene were then determined by making all possible pair-wise comparisons of the four membranes. This analysis showed that 78 genes displayed increased expression (greater than 3 fold) in fetal over post-natal muscle, and that zero and one gene showed greater than 3 fold expression differences in fetal-fetal and postnatal-postnatal comparisons, respectively. Three genes were up-regulated in postnatal semitendinosus muscle, including alpha-actin, muscle alpha 7-integrin, and one muscle EST with no database match. These experiments show that cDNA macroarrays can identify differentially expressed genes in a cost-effective and rapid manner. Additional time points and Northern analyses will be required to confirm these predicted expression differences.

Key Words: Pig, Transcriptional profiling, Muscle

1401 Production of 17 cDNA libraries and successful EST sequencing of 10,124 clones from porcine female reproductive tissues. C.K. Tuggle*¹, J.A. Green², C. Fitzsimmons¹, R. Woods², R. Prather², S. Malchenko³, M.B. Soares³, C.A. Roberts⁴, K. Pedretti⁴, and T. Casavant⁴, ¹Iowa State University, Ames, IA, ²University of Missouri-Columbia, Columbia, MO, ³Pediatrics-University of Iowa, Iowa City, IA, ⁴ECE-University of Iowa, Iowa City, IA.

Sequencing of cDNAs expressed in reproductive tissues will provide useful information in identifying specific genes involved in quantitative traits for pig reproduction. We have produced a total of 17 libraries from

the following tissues: whole embryo (day 14, 20 and 45 of gestation); term placenta, anterior pituitary (day 0, 5 and 12 of estrus), hypothalamus (day 0, 5 and 12 of estrus) ovary (day 0, 5 and 12 of estrus) and uterus (day 12 and 14 of gestation). To determine the quality of these libraries, we have sequenced randomly selected clones from each library. A total of 10,124 sequences has been produced and will be submitted to Genbank (7,932 submitted to date). The average sequence read length across this dataset is 424 base pairs, with less than 22% shorter than 300 base pairs. As assessed by cluster analysis of 9,911 sequences, these data represent 6,655 different genes for a novelty rate of 67.2%. A sequence similarity analysis using the BLAST program and publicly available data within Genbank (ca. 53,660 porcine genes and ESTs as of December 20, 2000) indicates that 3,939 (59 %) of these clusters are unique relative to existing porcine Genbank entries (BLAST score <50). Further, over 900 (14%) have a significant match with human sequences (BLAST score >400). Thus, these sequences are highly useful for comparative mapping with the human genome. To facilitate selection of genes for such mapping, we have developed software to predict the pig cytogenetic location based on human cytogenetic and RH mapping data. Preliminary testing of the IMpRH panel indicates no technical problems; over 15 loci have been mapped using both the SCHP and the RH panel at this point. A WWW site has been established for public access to these sequences and the analysis data (<http://pigest.genome.iastate.edu>). In summary, this EST project has currently identified over 10,124 pig reproduction ESTs, representing over 3,939 new genes, toward a project goal of 20,000 submissions to Genbank.

Key Words: Pig, Expressed sequence tag, Reproduction

1402 Development of a physical map of bovine chromosome 4 that contains the gene responsible for Bovine Progressive Degenerative Myeloencephalopathy (PDME). Mheni Ben Abdallah*, Scott Speidel, Emily Oberg, and Sue DeNise, University of Arizona, Tucson, AZ, USA.

Bovine Progressive Degenerative Myeloencephalopathy (PDME) or Weaver Syndrome is recessively-inherited neurological disease found in the Brown Swiss breed. It has been reported that sires that are heterozygous for PDME had significantly higher genetic merit for milk and fat yield than normal homozygotes due to linkage with a major gene or a pleiotropic effect. To identify candidate genes for PDME, we intend to develop a bovine BAC-contig in the region containing the gene, and use comparative genomics to identify candidate genes and orient the contig. A recombination event in the region near BM1224 indicates that PDME is located telomeric of this microsatellite marker. Initial screening of a bovine BAC library (RPC1-42, BACPAC Resources) using BM1224 and the next mapped marker, BM6437, provided 5 positive BAC clones. We have begun constructing a BAC contig that physically spans the region by end-sequencing these clones and then shotgun sequencing the BACs that comprise the shortest tiling distance. Our rationale is to establish BAC-based contigs by using the human map for orientation and walking toward the center of the contig. The homologous human region is 7p14-13 region. Bovine sequence from the BAC clones are aligned onto human BAC sequences in the region. New EST and STS sequences identified from the human map are amplified in bovine and mapped in the 12000 rad radiation-hybrid panel to determine relative location in the bovine. Using the combined strategy of the bovine physical map and comparative genomics, we hope to identify likely candidates for PDME that can be sequenced and studied in affected and normal animals.

Key Words: Dairy cattle, Genetic diseases, Physical mapping

1403 Comparative mapping and linkage analysis to identify the genetic region responsible for Bovine Spinal Muscular Atrophy (SMA). E.A. Oberg*¹, N. Vukasinovic², and S.K. DeNise¹, ¹University of Arizona, ²Utah State University.

Spinal Muscular Atrophy (SMA) is a recessively-inherited neurological disease found in the Brown Swiss breed. Clinical signs of SMA can be observed as early as 3 to 4 weeks of age and result in death of the calf by 12 weeks. Bovine SMA has symptoms similar to several human diseases that have already been chromosomally localized; thus, a search for homologous diseases/symptoms between humans and cattle was performed in order to obtain potential candidate regions to begin a logically organized genome scan in affected families. A resource population of sixty carrier and non-carrier animals was identified through progeny testing and DNA samples collected. Depending on the size of

the candidate regions and the heterozygosity of the chosen markers, approximately 10 microsatellite markers per chromosome are used in the analysis. Microsatellite marker linkage analysis will be performed on the genotypes obtained from animals in the resource population to identify the putative regions where the disease gene resides. The ultimate goal is to create a genetically based test that can easily identify SMA carrier animals so as to eliminate high-risk matings.

Key Words: Gene Mapping, Dairy Cattle, Genetic Diseases

1404 Genetic analysis of candidate genes for Weaver Syndrome in Brown Swiss cattle. Scott Speidel*, Emily Oberg, Mheni Ben Abdallah, and Sue DeNise, *University of Arizona, Tucson, AZ/USA.*

Weaver Syndrome or Bovine Progressive Degenerative Myeloencephalopathy (PDME) is a recessively inherited neurological disease described in Brown Swiss Cattle that has been mapped to bovine chromosome 4 (BTA4). To locate the PDME causative gene, human and murine candidate loci have been identified that map to homologous regions on BTA4. The reelin gene (RELN) has been shown to control neuronal migration in the developing brain in mice; and mutations in the gene have shown similar symptoms to PDME. It maps to the long arm of human chromosome 7, which is homologous to BTA4. Primers developed from human studies were used to amplify a 159-bp fragment, which encompasses positions 1136-1295 of the human RELN sequence. After initial sequencing of direct PCR product, the fragment had a 90.06% homology score with human RELN. Mapping RELN using the 5,000 (5K) rad radiation hybrid panel placed the RELN gene outside the area of interest on BTA 4, telomeric to the microsatellite TGLA 116. A recently discovered recombination event narrowed our focus down to an 8 cM region on BTA 4. Human BAC clones in the homologous region of HSA 7 have been identified to contain genes, which would aid in fine mapping the region. Two EST's discovered on HSA 7 in the homologous human BAC will be mapped in cattle to provide a framework for the bovine BAC contig development. The first is annotated as a neuronal precursor to neuroepithelial cells (Accession #AA218986). The second EST has an unknown function and is labeled KIAA0087 gene product (Accession # D42038). These two gene products have been amplified in bovine genomic DNA. The next step is to sequence the product to verify homology, and then they will be mapped using the 12,000 rad radiation hybrid panel.

Key Words: Gene Mapping, Dairy Cattle, Genetic Diseases

1405 Evaluation of genetic relatedness and diversity in five goat breeds using randomly amplified polymorphic DNA (RAPD) analysis. J. Luo*¹, Z. G. Liu², G. S. Yang², and X. M. Zhen³, ¹*E(Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK,* ²*Northwest Agricultural University, Yangling, Shaanxi, China,* ³*Biotechnology Laboratory of Hubei Agricultural Science Academy, Wuhan, Hubei, China.*

The primary objective of this study was to apply randomly amplified polymorphic DNA technique to evaluate genetic relatedness and diversity among five goat breeds, namely Boer, Saanen, Angora, Shaannan white, and Guanzhong dairy goat. They were meat, dairy, fiber, and indigenous dual-purpose breed, respectively. The analysis was based on band-sharing frequency, genetic distance, and Shannon diversity index. Blood samples were collected from 17 Boer, 14 Saanen, 13 Angora, 11 Shaannan white, and 5 Guanzhong dairy goats via jugular venipuncture for each individual DNA isolation. DNA pools were formed for 7 individuals from each breed except 5 of Guanzhong dairy goats. A total of 20 arbitrary 10mer primers with GC content of either 40, 50, 60, or 70%, designed according to references and manufacturer's recommendations and synthesized by Dalian Biotechnology company of China thereafter, were employed in RAPD analysis. Seventeen of 20 primers detected an amplified pattern with 2 to 11 bands, 4 of which had amplified polymorphic fragments in each breed; the between-breed average band sharing frequency was from 0.91 to 0.98. Neils standard genetic distance was in the range of 0.02 to 0.09, and a dendrogram based on Neils distance from amplification patterns of four random primers in five goat breeds was constructed. As expected, the estimate of distance between Saanen and Guanzhong dairy goat was lowest among goat breeds. The Shannon diversity index of each goat breed was 0.54, 0.19, 0.12, 0.35 and 0.34, respectively, which indicated a large genetic diversity in Boer, Shaannan white, and Guanzhong dairy goat populations in the sampling region.

It was confirmed that RAPD marker analysis can be used to determine genetic diversity and relatedness among and within goat breeds.

Key Words: RAPD, Genetic Diversity, Goat Breed

1406 PIT-1 gene sequencing and mutation analysis in sheep. E Bastos*¹, I Parmentier², I Santos³, A Cravador⁴, H Guedes-Pinto¹, and R Renaville², ¹*University of Tras-os-Montes e Alto Douro, Vila Real, Portugal,* ²*Gembloux Agricultural University, Gembloux, Belgium,* ³*National Zootechnical Station, Santarem, Portugal,* ⁴*University of Algarve, Faro, Portugal.*

The pituitary-specific transcription factor Pit-1/GHF1 is a member of the POU domain family of regulatory proteins. It is required for activation of the growth hormone, prolactin, and thyroid stimulating- β genes in somatotrope, lactotrope, and thyrotrope cell types, respectively. In humans, mutations in Pit-1 have been associated with pituitary dwarfism and it has been proposed that this transcription factor can have a contribution in the pathogenesis of pituitary adenomas. In farm animals, there is a strong correlation between a mutation on exon 6 of this gene and milk production in bovine. The aims of the present study were to sequence the Pit-1 gene in sheep and optimize a methodology for the detection of mutations in the coding region. Specific primers were designed for the amplification of the sequence between two subsequent exons, based on the comparison of the gene sequence in human and the mRNA sequence in ovine. Five different clones were obtained, using the Invitrogen PCR cloning kit. The sequencing result was used to design primers near the exons in order to screen possible mutations, by the methodology BESS T/G scan. As the Pit-1 gene can play an important role in lactation and growth, the identification of mutations in this gene can contribute to the explanation of the differences in production and open new prospects for marker assisted selection.

Key Words: Pit-1, Sequence, Polymorphisms

1407 The pairwise relatedness between relatives conditional on genetic markers. Yuefu Liu*¹, Gerald Jansen¹, and Ching Lin², ¹*University of Guelph, Guelph, Canada,* ²*Agriculture and Agri-Food Canada, Lennoxville, Canada.*

The development of molecular genotyping techniques makes it possible to analyze a quantitative trait on the basis of individual loci. With marker information, the classical theory of estimating the covariance between relatives has to be reformulated to improve the accuracy of estimation. This study derived an algorithm for computing the covariance between relatives conditional on a single marker or two flanking markers, and provided procedures for calculating the conditional relationship coefficients due to allelic effects, additive effects, dominance effects, and epistatic interactions including additive by additive, additive by dominance, dominance by additive and dominance by dominance. The relationship coefficients were computed based on conditional transmission probabilities of QTL alleles, which are, in turn, inferred from the transmission probabilities of marker alleles. An example data set with pedigree and marker genotypes of two linkage groups was used to demonstrate the procedure developed. Although this study dealt with two QTLs coupled with linked markers, the same principle can be easily extended to a multiple QTL situation.

Key Words: Covariances between relatives, Additive and non-additive relationship matrices, Genetic markers

1408 Marker assisted selection for first calving age at embryo level: a simulation study. A. J. M. Rosa*¹, R. B. Lobo¹, P. Bijma², M. Rutten², H. N. Oliveira³, and J. van Arendonk², ¹*USP - Ribeirao Preto, SP/Brazil,* ²*Wageningen Institute of Animal Science, Wageningen, Holland,* ³*UNESP - Botucatu, SP/Brazil.*

Potential genetic benefits of marker assisted selection (MAS) at the embryo level to improve first calving age were evaluated by simulation of a MOET closed nucleus, with discrete generations, multi-stage selection (with or without embryo pre-selection) and QTL information. The QTLFCA were included in the selection index as a correlated trait with total substitution effect ranging from .00 to .95 of the additive genetic variance (σ_a^2). In the first simulated situation, MAS at 2 years of age resulted in higher response to QTLFCA corresponding to higher proportion of the σ_a^2 due to the increase in accuracy. Genetic response was increased to .68, 1.76 and 3.70% for QTLFCA with .02, .05 and .1 σ_a^2

reaching 55.76% for QTLFCA of $.95 \sigma_a^2$, while the accuracy increased from .513 and .543 to .981 and .955, respectively for sires and dams. Response to MAS, with QTLFCA effect corresponding to .1, .3 and .5 σ_a^2 , at embryo level and different pre-selection rates was evaluated resulting in lower genetic gains when compared to MAS with one-stage selection due to the lower intensity at 2 years old (when more information is available: own performance for cows, full and half sibs) resulting in smaller total accuracy. Therefore, it is possible to obtain responses larger than 98% of the total response using embryo selection rates of .6, .3 and .2 for QTLFCA substitution effects of .1, .3 and .5 respectively. The production of 3 times more embryos allow to increase the genetic gain approximately 23%, due to the increase in selection intensity. When 13 of the 40 embryos were transferred, even markers with small effect ($.02, .05 \sigma_a^2$) could be used in MAS resulting in satisfactory response: 9.0% and 12.6%, respectively. Considering that most of the total cost in a MOET nucleus breeding program is due to maintenance of recipients and feeding growing animals until selection age the MAS utilization on embryo pre-selection can lead to a substantial improvement in the genetic response, even with markers with small substitution effect, without relevant increase in costs.

Key Words: Marker assisted selection, Embryo pre-selection, Beef cattle

1409 A heterogeneity model for estimating the number of QTL alleles in a segregating population. Jean Xu* and Yang Da, *Department of Animal Science, University of Minnesota*.

A frequently observed phenomenon in data analysis for the detection of a quantitative trait locus in a segregating population is the genetic heterogeneity of a quantitative trait among different families. This heterogeneity could be due to the following situations: 1) some families do not have segregating alleles so that marker effects tend to be zero for those families, 2) families with segregating QTL alleles in fact have multiple QTL alleles, 3) different families have the same QTL effect but different marker-QTL recombination frequencies, and 4) different families have multiple QTL alleles and different marker-QTL recombination frequencies. Assuming situation 2), families with similar QTL effects can be placed in the same group using a cluster analysis and a heterogeneity model can be used to estimate the QTL effects of different family groups. Then, the number of QTL alleles can be estimated under the assumption of equal difference between two adjacent QTL alleles when QTL alleles are ordered according to the sizes of their effects. Let k = the number of QTL alleles, α_m = the average of QTL effects of different family groups, and α_d = the largest QTL distance obtained as the difference between the largest and smallest QTL effects. Then, the number of QTL alleles can be estimated as $k = [2 + (3\alpha_m/\alpha_d - 1)] / (3\alpha_m/\alpha_d - 1)$.

Key Words: Heterogeneity model, QTL alleles, segregating population

1410 Evidence of paternally imprinted QTL around *IGF2* in a Berkshire-Yorkshire cross. H. K. Lee², J. C. M. Dekkers*¹, R. L. Fernando¹, and M. F. Rothschild¹, ¹*National Livestock Research Institute, Korea*, ²*Iowa State University, Ames, IA*.

A paternally imprinted QTL with major effect on muscle mass and fat deposition near *IGF2* on SSC2 has been reported for crosses of the Large White with Pietrain and Wild Boar breeds. Our objective was to confirm the presence of an imprinted QTL on SSC2 in an F2 cross between the Berkshire and Yorkshire breeds. Data on average backfat (ABF) and loin eye area (LEA) from 512 F2 animals and genotypic data for eight markers on SSC2 were used. Breed cross regression interval mapping was implemented using the following QTL models: Mendelian (additive and dominance effects), full imprinting (allowing for different maternal and paternal allele effects plus dominance), paternal imprinting (only paternal expression), and maternal imprinting (only maternal expression). Tests of each model against the no-QTL model and tests of full imprinting against the Mendelian, paternal and maternal imprinting models were used in a decision tree to determine presence and mode of inheritance of QTL. Chromosome-wise significance thresholds were determined by permutation. Tests of the Mendelian against the no-QTL model showed no evidence of QTL for ABF and LEA ($P > 0.05$) but tests of the full imprinting against the no-QTL model detected a QTL for both traits at the same position on the distal end of SSC2p ($P < .01$ for LEA and $P < .02$ for ABF), near *IGF2*. Further testing for mode of inheritance showed that the full imprinting model was not significant over

paternal imprinting ($P > .10$) but highly significant over maternal imprinting ($P < .01$), indicating evidence for exclusive paternal expression. The final analysis of paternal imprinting against the no QTL model was highly significant ($P < .01$). Favorable alleles originated from the Yorkshire and, when transmitted through the sire, reduced average backfat by .1 cm and increased LEA by 1.0 cm², compared to Berkshire alleles. Evidence of these QTL, which were not detected based on a Mendelian model, confirms that the *IGF2* region is imprinted in pigs and harbors important QTL for muscularity and fat deposition. Supported by USDA CSREES # 00-52100-9610

Key Words: QTL detection, Imprinting, *IGF2*

1411 Combined interval mapping of QTL using mixed models in reference families with complex pedigrees and its application to chromosome 13 of swine. X. L. Wu and C. Lee*, *Hallym University, Chuncheon, Korea*.

A method for mapping quantitative trait loci (QTL) was introduced incorporating information from various types of progeny and from multiple generations. Effects and positions of QTL were obtained by a joint estimation using the joint QTL-marker distribution of mixed populations or by a weighted least square method. Interval mapping was used to illustrate the theory based on a mixed model. Analysis of variance using multi-point analysis suggested that a Danish pig family carried a QTL on chromosome 13 which significantly affected slaughter weight (SWT) and average daily gain to slaughter (ADSG) ($P < 0.05$), but QTL effect on backfat depth (BFDP) was inconsistently observed. This QTL was located between loci SW1898 and SW398 ($\rho = 0.52036$). This was a region which flanked the PIT1 gene, an essential transcriptional regulatory factor of growth hormone, prolactin and thyrotropin β subunit. This result agreed with previous results that suggested a QTL for other growth traits at the estimated PIT1 position. Variance contributed by this QTL was 9.37% for SWT and 9.45 % for ADSG.

Key Words: Linkage Maps, Segregation Families, QTL

1412 PIT-1, a candidate gene for mass assisted selection in dairy bulls. I. Parmentier*¹, N. Gengler², S. Fontaine¹, B. Auvray², T. Burnside³, D. Portetelle¹, and R. Renaville¹, ¹*Gembloux Agricultural University, Animal and microbial biology unit, Gembloux, Belgium*, ²*Gembloux Agricultural University, Husbandry unit, Gembloux, Belgium*, ³*Semex-Alliance, Guelph, Canada*.

Pit-1 is a protein important for pituitary cell differentiation and proliferation. It acts as a transactivator that regulates growth hormone and prolactin, TSH-b genes. In a previous study (Renaville et al. 1997, J. Dairy Sci. 80, 3431-3438), we have reported that the polymorphism associated to a transition A to G in the exon 6 of the gene could be associated to milk performances. The aim of this study was to search for eventual associations between Pit-1 polymorphism and dairy production traits by using a representative population of dairy sires. DNA was extracted from 1100 A.I. Holstein bulls using in A.I. scheme by Semex-Alliance (Guelph, Canada). A primer-specific PCR test has been developed to reveal the two alleles of Pit-1 gene which are called A and B. A mixed linear animal model including milk data of 2,400,000 lactations from 1,100,000 daughters of tested bulls was developed. The allelic frequencies were 53% and 47% for A and B respectively. Allelic frequencies were introduced as regression into the mixed linear animal model. The results showed an a value of +46,3 kg, + 1,9 kg and + 1,5 kg for milk, protein and fat yield, respectively. This a value represents the effect, on the trait, of the substitution of a B allele by a A allele. In conclusion, this study showed a significant relationship between the A allele of Pit-1 and dairy production traits of Holstein bulls. This gene could be considered as an interesting tools for marker assisted selection of dairy bulls. (Supported by the Belgian Ministry of Small Enterprises, Traders and Agriculture (grant 5983S), Semex-Alliance (Guelph, Canada) and Tomen Corp. (Tokyo, Japan))

Key Words: Pit-1, Marker, Lactation

1413 Composite interval mapping analysis of milk production and health traits in US Holsteins. A. B. Kurtz*, S. L. Rodriguez-Zas, H. A. Lewin, and D. W. Heyen, *University of Illinois at Urbana-Champaign, Urbana, IL.*

Identification of quantitative trait loci (QTLs) affecting milk, fat and protein yield, and somatic cell score was performed using composite interval mapping (CIM). Daughter yield deviations and predicted transmitting abilities from eight US Holstein families in a granddaughter design were analyzed. Sons were screened for 174 microsatellite markers distributed across 29 autosomes. Family sizes ranged from 72 to 203 sons and the average number of informative markers per chromosome was three. Interval mapping (IM) model was combined with significant ($P < 0.05$) regressors representing markers at least 10 cM from either side of the interval studied to account for other loci. Univariate and multivariate CIM analyses were implemented within each family using QTL Cartographer. Univariate genome-wide critical P-values were calculated using permutation tests and chromosome-wise critical P-values were calculated using a Bonferroni correction. On chromosome six, results from univariate and multivariate IM ($P < 0.05$) and CIM ($P < 0.025$) models identified a QTL located at 80 cM affecting protein yield in family two. Single-marker model findings suggested similar associations ($P < 0.025$) between protein yield and consecutive informative markers, BMS518 (69 cM) and ILSTS97 (80.3 cM). On chromosome 14, univariate CIM identified a QTL at 1.5 cM affecting milk yield in family four. This finding was supported by multivariate IM, which located a QTL ($P < 0.001$) at 0 cM in family four, and by multivariate CIM that located a QTL at 3.5 cM in family four ($P < 0.01$) and at 5.5 cM in family five ($P < 0.001$). The multivariate CIM approach identified a QTL at 26.3 cM on chromosome 14 for family four ($P < 0.001$), which is consistent with single marker results that identified a marker (BM1508) at 30.5 cM with a significant ($P < 0.05$) effect on somatic cell score. Our study confirmed that the comprehensive multivariate CIM model provided precise QTL estimates while accounting for QTL outside the interval under study.

Key Words: Quantitative Trait Loci, Maximum Likelihood, Permutation

1414 Interval mapping of quantitative trait loci affecting yield and health traits in dairy cattle. A. B. Kurtz*, S. L. Rodriguez-Zas, H. A. Lewin, and D. W. Heyen, *University of Illinois at Urbana-Champaign, Urbana, IL.*

Phenotypic records for milk, fat and protein yield, and somatic cell score were combined with genetic data from eight US Holstein families in a granddaughter design. The phenotypes were regressed on the conditional probabilities of inheriting a quantitative trait locus (QTL) allele at 1-cM intervals along the chromosome, using an interval mapping (IM) model. A total of 1065 sons were screened for 174 microsatellite markers across all autosomes. The number of informative markers per chromosome ranged from one to eight. A weighted least squares analysis was performed within and across families with weights equal to the variance of the trait. The impact of the use of two different phenotypic measures, daughter yield deviations (DYD) and predicting transmitting abilities (PTA), was compared. Genome-wise critical P-values were calculated using a Bonferroni correction to account for multiple testing. Small differences were observed between the estimates obtained for PTA and DYD. A significant effect ($P < 0.001$) for somatic cell score was detected in family four on chromosome 23 (3 cM). This autosome includes the bovine major histocompatibility complex. On chromosome three, significant effects for milk and protein yield were found. For family one, a potential QTL with significant effect ($P < 0.001$) on milk yield was located at 46 cM and supported by single marker findings. Both DYD and PTA models for protein yield estimated the same position (26 cM) using within and across family analyses. The estimates of the effects were similar, meeting suggestive significance levels ($P < 0.0001$). These results support those obtained with single marker models that detected effects of nominal significance ($P < 0.05$) on protein yield in the same family (five) for the two markers flanking the 16-cM interval containing the effect at 26 cM. The IM model provided an estimate of QTL position in proximity of the center of an interval that was not clearly resolved using single marker models.

Key Words: Least Squares, Protein, Somatic Cell Score

1415 Identification of genome positions associated to monthly production and health records using a single-marker model. S. L. Rodriguez-Zas*, B. R. Southey, H. A. Lewin, and D. W. Heyen, *University of Illinois, Urbana, IL.*

Many traits of agricultural importance such as monthly dairy records are measured repeatedly over time. Current methods of detection of quantitative trait loci (QTL) use single (average or cumulative) phenotypic measurements thereby ignoring the pattern that these traits exhibit. The objective was to identify genome positions expressed at specific stages of lactation or influencing the shape and scale of the lactation curve. A nonlinear single-marker model was used to describe monthly milk yield, fat and protein percentage, and somatic cell score (SCS) records from daughters of 475 sons across three Holstein families. A total of 46 markers along six chromosomes were fitted. Six percent of the hypothesis tests across families, traits, markers, and parameters were significant ($P < 0.0001$) after adjustment for multiple tests. Some positions had significant effects on all parameters describing the lactation curve (chromosome 3, marker at 41 cM affecting the shape and scale of the SCS curve) meanwhile other markers were associated with a significant variation on a specific descriptor of the lactation curve (chromosome 6, marker at 64 cM, only affecting the shape of the protein curve). These results suggest the presence of putative QTL in the proximity of the significant positions that influence not only the magnitude but also the profile of the lactation curve. Identified positions can be incorporated into selection decisions to alter the persistency of production or the somatic cell score fluctuations during lactation.

Key Words: Lactation curve, Longitudinal data, Non-linear model

1416 Random regression models to estimate genetic growth parameters of young zebu beef cattle. E. S. Sakaguti*¹, R. L. Quaas², M. A. Silva³, E. N. Martins¹, P. S. Lopes⁴, and L. O. C. Silva⁵, ¹Universidade Estadual de Maringá, Maringá, Brazil, ²Cornell University, Ithaca, New York, ³Universidade Federal de Minas Gerais, Belo Horizonte, Brazil, ⁴Universidade Federal de Viçosa, Viçosa, Brazil, ⁵EMBRAPA - Gado de Corte, Campo Grande, Brazil.

A total of 66,430 body weights measured at ages ranging from 365 to 650 days on 28,234 Tabapua beef cattle born from 1975 to 1997 and raised under Brazilian pasture conditions were used to evaluate the application of random regression models (RRM). Linear Legendre polynomials were used to describe random effects. Likelihood ratio test was used to compare the animal models. A simple repeatability model was inappropriate to evaluate the current data file because additive genetic and permanent environmental effects were dependent of the age of animal. Therefore the model that used continuous functions to describe these two effects had the most adequate fit. Growth rate estimated by the linear random regression coefficient had heritability equal 0.54 and genetic correlation with live weight at 507.5 days of age equal 0.47. The heritabilities for the live weight ranged from 0.3 to 0.4 within the age interval considered.

Key Words: Random regression, Genetic parameters, Beef cattle

1417 Inversion-free method for variance component estimation under the animal model. Jean Xu* and Yang Da, *Department of Animal Science, University of Minnesota.*

Estimation of variance components using maximum likelihood (ML) or restricted maximum likelihood estimation (REML) under the animal model requires the inversion of the coefficient matrix of the mixed model equations. Matrix inversion is computationally intensive and is a limiting factor for the number of animals that can be analyzed jointly. Under the assumption of constant relationships among family members and independent families, an inversion-free method for variance components is available to estimate three variance components. These three variance components can be additive, dominance, and residual variance components, or additive, permanent environment, and residual variance components. Formulae of this inversion-free method were developed for both ML and REML.

Key Words: Inversion free method, Variance component, Animal model

1418 Incorporating external information in multi-breed genetic evaluation. R. L. Quaas* and Z. Zhang, *Cornell University, Ithaca, NY.*

Some sires in multi-breed genetic evaluation have highly accurate genetic evaluations based on data not included in the multi-breed evaluation. In some cases, the external information is much greater than the internal. It is dissatisfying to breeders that sires rank differently, especially when the multiple breed evaluations are based on relatively limited data. Application of Bayesian principles with some simplifying assumptions provides a framework for incorporating external information. The external information is assumed to be contained in the animals' external Expected Progeny Differences (EPD) and their accuracies. Parameters are included to account for base differences. Effects of incorporating external EPD were investigated with data drawn from the American Simmental Association database. The data set included herds with both Simmental- and Angus-sired calves plus a sample of large Simmental herds. It contained 40680 records of calves sired by 1047 bulls. Data were analyzed with and without incorporating external information. The external information consisted of 64 American Angus Association (AAA) EPD and 51 Red Angus Association of America (RAAA) EPD. Average accuracies of external EPD were 0.91, 0.89, 0.87 and 0.82 for BWT, WWT, YWT and milk from AAA, and 0.78, 0.72, 0.70 and 0.64 for RAAA. Without external information rank correlations between internal EPD and AAA EPD were 0.49, 0.50, 0.47, 0.27 for BWT, WWT, YWT and milk. The corresponding values were 0.64, 0.68, 0.59, 0.20 for RAAA bulls. Following incorporation of external information the rank correlation between internal EPD incorporating external information and external EPD from AAA were 0.87, 0.91, 0.90, 0.91 for BWT, WWT, YWT and milk. For RAAA sires the corresponding values were 0.91, 0.93, 0.95, and 0.90. In contrast the changes for purebred Simmental sires were small; all rank correlations were > .999. The procedure succeeded in ranking Angus bulls similarly to their external EPD but did not effect the ranking of Simmental sires.

Key Words: Expected Progeny Difference, Bayesian Analysis, Beef Cattle

1419 Bayesian linear mixed models employing the contaminated normal distribution: a simulation study in animal breeding. I. G. Pereira*, G. J. M. Rosa, and H. N. Oliveira, *UNESP - Botucatu, SP/Brazil.*

The Gaussian distribution is often assumed in applications of linear mixed model for quantitative traits in animal breeding. This assumption, however, makes inferences vulnerable to the presence of discrepant observations, such as those originated from preferential treatment or error in measurements. Thick-tailed distributions such as the Student-*t* process have been suggested for robust estimation. Here, the contaminated normal distribution is assumed for the residuals of linear mixed models in beef cattle evaluation. A simulation study is used to compare the performance of the Gaussian model and this robust alternative. Fifty data sets were simulated, considering two levels of fixed effects and five generations with 200 animals each, without selection. Different levels of contamination were studied. A Bayesian framework was adopted, and the Gibbs sampler and the Metropolis-Hastings algorithm were used to carry out the posterior analyses. Single chains were run for each model and data set, with 250,000 iterations, after burn-in. Except for data sets without contaminants, the robust model presented better estimates of residual variance. Estimates of heritability were similar for all models, but predict genetic values obtained by the robust model were closer to the real breeding values, as assessed by correlation analysis. The results suggest that the contaminated normal linear mixed model offers a flexible alternative for robust estimation in animal breeding.

Key Words: Contaminated normal distribution, Linear mixed models, MCMC

1420 Effect of reducing the frequency of milk recording on accuracy of genetic evaluation using a random regression model. J.J. Tosh¹, J.A.B. Robinson*¹, G.B. Jansen¹, and C.Y. Lin², ¹Centre for Genetic Improvement of Livestock, University of Guelph, Ontario, Canada, ²Dairy and Swine Research and Development Centre, Agriculture & Agri-Food Canada, Lennoxville, Quebec.

Accuracy of national dairy cattle genetic evaluation programs that use a random regression model was studied to determine the effect of reducing monthly milk recording to less frequent schemes. A large dynamic

population of dairy cattle was stochastically simulated. The population consisted of 1000 herds of 45 cows on average each and heifers, as well as young (n = 160) and proven (n = 40) bulls at an AI stud. Selection and mating mimicked a progeny test with weak to moderate selection on first lactation production (phenotype). All cows left the herd upon completion of their third lactation. Test day records for monthly farm visits were generated for milk, fat, and protein yield, and somatic cell score using a multiple-trait random regression model analogous to that used for genetic evaluation of dairy cattle in Canada. The simulation ran for a period of 20 years, and created more than 6.2 million records. Genetic evaluation was done using the records and industry software. Correlations between estimated breeding values and known true values (i.e., accuracies) were calculated. Accuracies for cows (n = 318680) and bulls (n = 590) were 0.773 and 0.940, 0.772 and 0.935, 0.758 and 0.934, 0.669 and 0.912, and 0.720 and 0.943 for milk, fat, and protein yield, somatic cell score, and lactation persistency, respectively. As expected, accuracy increased for cows with more lactations, and bulls with more daughters (mean = 451; range 1 to 2991). Genetic evaluation was also done after editing the data set to randomly eliminate test days, mirroring reduced milk recording. Halving the frequency of milk recording to every second month did not notably affect accuracy, which decreased by no more than 0.02 for any trait in cows; in bulls the effect was even smaller. Results indicated an average of ten records per cow would suffice as well as twenty. Corresponding reductions in the cost of milk recording could be great. Conducting on-farm milk recording every second month rather than monthly appears justified when a random regression model is used for genetic evaluation of large dairy cattle populations.

Key Words: Dairy Cattle, Milk Recording, Test Day Model

1421 Bayesian analysis of multiple-linear and categorical traits with varying number of categories. D.H. Lee*¹, I. Misztal¹, J.K. Bertrand¹, and R. Rekaya², ¹University of Georgia, Athens, Georgia, ²University of Wisconsin, Madison, Wisconsin.

The purpose of this study was to determine properties of a Bayesian method for joint analysis of multiple linear and categorical traits. Data sets with 10,630 records were simulated for to 3-trait linear models, with effects of sex, 50 contemporary groups, and 14,400 animals in 5 generations using BLUP selection. Selected traits were categorized with a binary and 4-categories. Bayesian analyses used Gibbs sampling. Residual variances for the categorical traits were assumed to be 1. The first threshold was set to 0, and the remaining thresholds were estimated. Sampling of the residual variances was from 1) the inverted Wishart (IW) distribution with rescaling (RS-IW), 2) IW distribution conditioned to residual variances of 1 for categorical traits by extending the methodology of Korsgaard et al. (1999, GSE 29:177) (RT-IW). Estimates were posterior means. Consistent estimates in models involving binary traits were obtained only after location parameters were reparameterized by weights resulting from conversion from samples of IW to RS-IW or RT-IW. This modification also increased the mixing rate several times in other models without affecting the estimates. No bias was observed with one categorical and several linear traits. In several models, biases were the same with RS-IW and RT-IW. In a model with three traits each with four categories, maximum biases were 0.01 for heritabilities and 0.14 for correlation. In a model with one binary and two linear traits, biases were 0.02 and 0.03 for heritabilities and correlations, respectively. In a model with two binary and one 4-category traits, these biases were 0.05 and 0.57 with RS-IW, and 0.04 and 0.30 with RT-IW. Analysis of multiple linear and categorical traits using a Bayesian method via Gibbs sampling is possible but biases can be expected especially for covariances and with binary traits. Differences when using samples of residual variance from RT-IW and RS-IW are small except with binary traits.

Key Words: Bayesian analysis, Threshold model, Reparameterization

1422 Analyses of sequential weights of Brazilian Zebu cattle using a multiple trait model by REML and Bayesian method. P. R. C. Nobre*¹, I. Misztal¹, S. Tsuruta¹, D. Lee¹, J. K. Bertrand¹, L. O. C. Silva², and P. S. Lopes³, ¹University of Georgia, ²CNPGC/Embrapa, Brazil, ³UFV, Brazil.

The purpose of this study was to estimate parameters of birth weight and sequential weights of Nellore cattle. Data collected by the Brazilian Zebu Breeders Association consisted of 620,528 records collected from 1975 to 1999. Weights were recorded at 10-110 days, 102-202

days, 193-293 days, 283-383 days, 376-476 days, 467-567 days, 551-651 days and 633-733 days, respectively. Two sample data sets with all known ancestors with genetic ties were created. The number of animals from all herds was 18,889 and 16,161 from herds with no missing traits. Records preadjusted to fixed age were analyzed by a multiple trait model, which included the effects of contemporary group, class of age of dam, and direct, maternal and permanent environmental effects. Analyses by REML were conducted five traits at a time, and analyses by the Bayesian method using block Gibbs sampling involved all nine traits. For REML and the first data set, the range of estimated direct genetic correlations for each pair of traits was 0.43 to 0.99, with higher values between weights at higher ages. Direct heritability varied from 0.17 to 0.33, and was highest for weight at 551-651 days; however, ma-

ternal and permanent environmental variance decreased after an age of 193-293 days. Additive and residual estimated variance increased from birth weight through weight at 551-651 days, however maternal and permanent environmental variance decreased after age of 193-293 days. Heritabilities with the complete data set were slightly lower. With the Bayesian method, chain length of 50,000 was insufficient to obtain consistent maternal and permanent environment estimates, especially for weights over 476 days. This is most likely due to extreme correlations between these traits. The parameter estimates will be used to validate parameter estimates obtained from random regression models.

Key Words: Beef cattle , Covariance components, Longitudinal data

PSA Genetics

1423 Influence of genetics on phytate phosphorus utilization by chickens. T. N. Smith, S. E. Aggrey*, R. I. Bakalli, and G. M. Pesti, *University of Georgia*.

An experiment was conducted to determine whether there is a genetic basis for selection for phytate phosphorus (P) utilization in chickens. Fifty-eight Athens-Canadian random bred chickens were fed a phosphorus deficient diet and the phytate P levels in their excreta was determined by Near Infra-red Spectrophotometry. Five roosters categorized as High sire excreta phytate P (SEPP) (1.17 ± 0.002) and Low SEPP (1.09 ± 0.002) were selected to sire progeny. The SEPP values were significantly different ($P < 0.0001$) between the two sire groups. One hundred and seventy chicks from Low SEPP and 180 chicks from the High SEPP were hatched and fed a P deficient diet (.53% P). The chicks were sacrificed at 16 d by carbon dioxide asphyxiation and body weight (BWT) was recorded. The left tibia were collected for ash determination on a fat-free basis. There was a negative correlation ($r = -0.15$; $P = 0.0053$) between sire excreta phytate P and 16 d BWT. The correlation between SEPP and tibia ash was also negative but not significant ($r = -0.01$; $P > 0.05$). Progeny from Low SEPP had higher BWT (152.7 ± 1.5 g) than progeny from High SEPP (146.8 ± 1.4 g) ($P = 0.0042$). Similarly, progeny from Low SEPP had higher tibia ash ($36.57 \pm 0.31\%$) than progeny from High SEPP ($35.55 \pm 0.03\%$) ($P = 0.0187$). This implies that sires that excrete low phytate P, that is, those that are better able to utilize phytate P, produced progeny that were significantly heavier at d 16 and had better bone mineralization than progeny sired by poor phytate P utilizers.

Key Words: Broilers, Phytase, Phosphorus

1424 Inheritance of Alkaline Phosphates in Local Iraqi Chicken and its association with Production. Ali Al-Hillali¹ and Khalid Al-Soudi*², ¹*Iraqi Atomic Energy Commission, Baghdad, Iraq*, ²*Animal Production Department, Agriculture College, Baghdad University, Baghdad, Iraq*.

Ninety eight dams and twenty one sires representing the parent stock of local Iraqi chickens, and their progeny (305 pullets) were typed for alkaline phosphates isozymes and activity in order to assess the effect of sex, age and genotype. Genetic analysis revealed three types of electrophoretic isozymes, namely fast, slow and a mixture of a fast and slow band. Gene frequencies of the fast band were 0.41 and 0.39 and that for the slow band were 0.59 and 0.61 for dams and progeny flocks, respectively. Furthermore, age, sex and type of enzyme were found to have significant effects on enzyme activity, and birds of fast isozyme type had higher egg weight, lower age at sexual maturity and higher body weight at sexual maturity. Heritabilities of plasma alkaline phosphatase at different ages and economic traits ranged from moderate to high. Phenotypic, genotypic and environmental correlations between level of plasma alkaline phosphatase and growth rate and production characters indicated that the high activity of alkaline phosphatase was associated with higher growth rate at early stages, earlier sexual maturity and production of heavier but fewer eggs. Genetic and phenotypic correlations among enzyme activities at three ages were positive and high and expected genetic response after one generation of individual selection for alkaline phosphatase activity leads to improved production characters.

Key Words: Alkaline phosphates, Electrophoresis, Enzymes

1425 Multisource Multitrait Selection Indices For Genetic Improvement In Poultry Breeding Programs For Laying Hens. 2. Construction And Evaluation Of Various Indices. A. A. Enab¹, N. Kolstad², and F.H. Abdou¹, ¹*Fac. Of Agric., Minufya Univ., Shebin El-Kom, EGYPT*, ²*Agricultural Univ. Of Norway*.

Records on 11689 pullets progeny of 326 sires and 1546 dams produced in two hatches of four strains of White Leghorn hens raised under Norwegian conditions were utilized to construct and evaluate general, reduced and restricted selection indices. Eight indices were constructed using five traits and three sources of information for each trait in different combinations. The studied traits were age at sexual maturity (SM); egg number up to 260 days of age (EN); egg weight (EW); body weight (BW) and egg specific gravity (SG). The sources of information used in different combinations for each trait were individual's own phenotypic value (OP) and its full (FS) and half sister's (HS) average. It was noticed that the female general index which included all of the five traits and all of the three sources of information was found to be the most efficient index ($r_{TI} = 0.76, 0.65, 0.69$ and 0.61) in the four lines, respectively. The general index for males which included only two sources of information (FS&HS) for each of the five traits was found to be less efficient ($r_{TI} = 0.60, 0.54, 0.55$ and 0.51) in the four lines, respectively. The restricted index for both EW&BW in line 1 was the lowest efficient index ($r_{TI} = 0.50$). Expected and actual genetic progress (G) achieved in each trait was also maximum for female general index, for most traits in the four lines. It was noticed that the multisource index considering all of the five traits was superior to the multisource index involving only three or four traits. It was concluded that an index based on five traits and three sources of information could be applied to improve egg production and specific gravity traits.

Key Words: Genetic improvement, Multisource selection indices, Layers.

1426 A comparative genomic approach to identify-QTL's for growth in chickens. J. Funk-Keenan and G. F. Barbato, *The Pennsylvania State University, University Park, PA*.

It has long been surmised that different genes must influence different aspects of the growth curve. Unsurprisingly, different sets of QTLs influencing either early or late growth have been identified in mice and pigs. Using data from Vaughn et al (2000), we performed a modified candidate gene approach to identify QTLs influencing early growth in an F2 cross of chickens divergently selected for 14-day exponential growth rate (EGR). By aligning the mouse QTL's with the murine physical map; we targeted QTL's having syntenous genes in both the mouse and chicken genome. We selected the three to five microsatellite markers from the chicken linkage map based on their proximity to the locations of the murine syntenous genes in the chicken genome. Twenty-four microsatellite markers corresponding to six murine QTL's on six chicken chromosomes (1,3,4,5,6 and Z) were targeted for investigation. We chose the top and bottom 3% of chicks from the 14-day EGR distribution from the F2 cross. We then tested whether the microsatellite marker allele frequencies differed between the two tails of the distribution. Of the twenty-four microsatellite markers genotyped, eight markers (representing 5 putative QTL's) exhibited significantly different marker allele frequencies between birds having high or low 14-day EGR. The significant markers were located on chicken chromosomes 3,4,5,6 and Z. Notably, the putative QTL located on chromosome 4 is located at 148cM,

corresponding to a previously identified QTL for feed intake in chickens! These data support our hypothesis that the genetic architecture of growth is highly conserved across species and provides us with an opportunity to pursue QTL's that may have common mechanisms among most domestic animal species.

Key Words: Genetics, Growth, QTL

1427 Preliminary mapping of a gene affecting male fertility in the chicken. K Song^{*1}, F.G. Sizemore III², J.D. Kirby¹, and D.D. Rhoads¹, ¹University of Arkansas, Fayetteville, AR, ²USDA-Avian Disease and Oncology Lab, East Lansing, MI.

SDD is a dominant gene effecting degeneration of the ductules leading from the testis which results in defects in excurrent sperm maturation and thus production of degenerate, immotile sperm in a line of Delaware chickens (Froman, and Bernier. Biol. Reprod. 37:969-977, 1987; Kirby, Bernier, and Froman. Jr. Androl. 11:49, 1990). We used RAPD and bulked segregant analysis to identify a 1500 bp PCR product which appears linked to SDD. This PCR product was used to isolate a single BAC comprising approximately 100 kbp from a Jungle Fowl library (Dodgson). A single, polymorphic, simple sequence repeat was characterized from this BAC clone and was used to screen the East Lansing backcross mapping population. The repeat maps this BAC, and thus the 1500 bp product, to linkage group E41 on the East Lansing map. Based on gene order this linkage group appears syntenic with a region on the long arm of human chromosome 9. We are currently using additional microsatellites from this linkage group to more accurately position SDD on the chicken genomic map. Since most, if not all, of the genes in this region can be identified from the human sequence this should greatly speed isolation of the gene and molecular characterization of the defects responsible for the SDD phenotype. Although SDD was identified in the Delaware line it is likely that other alleles of the SDD gene affect male fertility in commercial poultry lines. Characterization of the SDD gene is of great importance in improving male fertility in the poultry breeding industry and the SDD gene should have homologs which affect testis development and fertility in humans and other species.

Key Words: fertility, male, sperm, gene mapping

1428 Zona pellucida 3 protein (ZP3) and gene (ZPC) expression in the turkey, *Meleagris gallopavo*. M. L. Block^{*1}, K. E. Nestor², and G. F. Barbato, ¹The Pennsylvania State University, University Park, PA, ²The Ohio State University, Wooster, OH.

The purpose of the following study was to characterize the protein expression of the turkey zona pellucida 3 protein (tZP3) and establish the cDNA sequence for tZP3 (tZPC). Six female turkeys from 2 genetic lines: F line and RBC line were used in this experiment. Using antibodies developed to specific amino acid sequences from chicken ZP3 (chZP3), western blot analysis of the perivitelline membranes (PVM) of laid turkey eggs revealed an immunoreactive band with the molecular mass of approximately 45 kD - which is larger than the 42kD chZP3 protein. Western blots of turkey tissue (liver, ovary, infundibulum, granulosa cells, and uterus) confirmed the presence of the tZP3 protein in granulosa cells, ovary and, unexpectedly, in the infundibulum. Further, not all subjects tested showed ZPC protein expression in the ovary and infundibulum. Turkey ZPC cDNA sequences were obtained by rtPCR using primers sets designed from chZPC. Sequence analysis of tZPC revealed high homology of the carboxy-terminus and the mid-portion of tZPC with both chZPC and qZPC (Japanese quail). Results from rt-PCR analysis in turkey tissues (liver, ovary, infundibulum, granulosa cells, and uterus) revealed tZPC mRNA expression in both granulosa cells and the ovary, but not the infundibulum. Together, these data suggest that expression of tZP3 may be temporally regulated in different tissues, perhaps related to hormonal cycling.

Key Words: Genetics, Turkey, Zona pellucida

1429 Molecular characterization of a partial inverted repetitive (PIR) DNA family in the chicken genome. Juan Li, Xiaofei Wang, and Frederick Leung^{*}, University of Hong Kong.

Tandem array repetitive sequences constitute a major component of the eukaryotic genome. Although the general characteristics of the tandem

repeats have been well characterized, the process involved in their origin and maintenance remain unknown. Chicken Partially Inverted Repetitive (PIR) DNA is a novel repetitive DNA family first characterized by our laboratory. With the basic repeat unit of 1.43Kb, it is characterized as tandem array pattern and located on chromosome 8. The central core of the repeat unit consists of 814bp showing 65% homology with w chromosome XhoI/EcoRI repeats. Sequence analyses show that they share the similar characteristics: (A)₃₋₄ and (T)₃₋₅ clusters are separated by 6-7 nucleotides. Such arrangement enables the A and T clusters to appear alternatively at every pitch of the DNA double helix. Hence, they behave as bent molecules in solution affecting the mobility of the repeat unit in the PAGE running slower as compared to its mobility in the agarose gel. Tandem array pattern of repetitive family in the genome is largely due to the unequal exchange happening within homologue chromosomes and sister chromatids. From sequence analyses, we have characterized an 86bp fragment unit flanking the central core in the inverted direction. Detailed sequence analyses further show high frequency of this inverted structure within this repetitive family. Our results indicate that other forces may be involved in the formation of higher organization region of the PIR family. Junction region analyses show that this inverted fragment often associated tandem array repetitive sequence with the non-tandem array repetitive sequence. Such arrangement indicates that the inverted structure may function as the recognition site during the evolution of this repetitive DNA family in the chicken genome. In addition, we observed polymorphism within different populations of domestic gallus gallus species indicating that PIR family is evolving fast. In conclusion, chicken genome may serve as an experimental model for the study of the origin and dynamics of repetitive DNA.

Key Words: Chicken, Repetitive sequence, Inverted structure

1430 The temporal expression of the Myogenic Regulatory Factor genes during proliferation and differentiation of satellite cells derived from chicken *Biceps femoris* and *Pectoralis major* muscles. A Sarver, J Richter^{*}, H Kocamis, S Gahr, and J Killefer, ¹West Virginia University, Morgantown, WV, 26506.

Satellite cells are responsible for postnatal skeletal muscle growth and repair. In the adult muscle, these mononucleate cells are mitotically quiescent until activated by an external stimuli, such as weight bearing or injury. Once activated, they undergo proliferation, differentiation and fusion into new or existing muscle fibers. Skeletal muscle myogenesis in vertebrates is largely managed by the myogenic regulatory factor gene family (MRF): Myo D, Myf-5, Myogenin, and MRF-4. We investigated the expression pattern of MRFs in chicken satellite cells isolated from *Biceps femoris*(BF) and *Pectoralis major*(PM) from the time of quiescence to the fusion of muscle fibers using reverse-transcription polymerase chain reaction (RT-PCR). There was little expression of any MRFs in the quiescent cell of both BF and PM satellite cells. Myo D was first expressed in both muscle types at 24 hr, corresponding with proliferation. Expression level then increased at 48 hr, remained constant to 96 hr, and began to decrease at 120 hr in both BF and PM cell cultures. Myf-5 displayed a similar expression pattern to Myo D in both BF and PM cell cultures. Myogenin was first expressed at 24 hr in both BF and PM. In BF satellite cells, expression remained relatively constant to 72 hr, and increased at 96 hr, corresponding to differentiation. Expression then decreased during late myotube formation (144 hr). In PM satellite cells, myogenin expression gradually increased from 24-96 hr, and then decreased at 120-144 hr. MRF-4 mRNA was at its highest at 72 hr in PM cell cultures and 144 hr in BF cultures. In PM, MRF-4 expression remained low during proliferation and gradually increased through differentiation (72-144 hr). This correlates with its role as a late differentiating gene. Predicted activities and patterns in the expression of members of the myogenic gene family correlate with satellite cell activation in the chicken.

Key Words: satellite cells, myogenic regulatory factor genes, muscle

1431 Social stress induced different alterations of dopamine concentrations and adrenal function in genetically selected chicken lines. P. Singleton*¹, Y. Chen¹, M.W. Muir², and H.W. Cheng¹, ¹USDA-ARS, Livestock Behavior Research Unit, ²Dept of Animal Science, Purdue University.

Dopamine (DA) and corticosterone (CORT) are involved in regulating animals' response to stress. The objective of this study was to examine whether alterations of DA concentrations and adrenal function are associated with behavioral response to social stress in two strains of White leghorns hens that were selected for high (HGPS) and low (LGPS) group productivity and survivability resulting from cannibalism and flightiness in multiple-hen cages. At 17-wk of age, hens were randomly assigned into single and 2-hen cages. The 2-hen cages contained one hen from HGPS or LGPS line and one from a commercial Dekalb XL line that was used as standardized genetic competitors. At 24-wk of age, seventy hens were bled (10 hens from 3 genetic line, 2 replicates, plus 10 extra testers). Plasma concentrations of DA were measured using HPLC. Changes of the adrenal function were indicated by plasma concentrations of CORT, and hypertrophy of the adrenal gland indicated as a percentage of adrenal gland weight/body weight (AW/BW). In single-hen cages, HGPS hens had heavier adrenal glands indicated as a greater AW/BW ratio ($P < 0.05$). However, LGPS hens tended to have greater plasma concentrations of DA ($P = 0.07$). In 2-hen cages, there were no difference in AW/BW ratio between HGPS and LGPS hens ($P > 0.1$). However, both plasma concentrations of CORT and DA were greater in LGPS hens ($P < 0.05$ and $P < 0.01$, respectively). The results suggest that social stress induced an up regulation of DA and adrenal function in LGPS hens but not in HGPS hens. The data was consistent with the previously findings that HGPS hens adapted better to social competition. Some of the parameters, such as concentrations of DA and CORT, could be used as an indicator of chicken well-being.

Key Words: Social stress, Dopamine and corticosterone, Genetic selection, chickens

ASAS/ADSA Forages and Pastures: Silages, Forage Quality, and Digestion

1433 Effect of wilting and molasses on silage quality of *Leucaena leucocephala*. T. Clavero*¹ and Rosa Razz¹, ¹La Universidad del Zulia.

An experiment was conducted in the dryland farming area of northwest, Venezuela in order to evaluate the ensiling properties of *Leucaena leucocephala* through microsilage techniques. Factors studied were two levels of molasses (0 and 5%) added during ensiling and wilting for 0 and 3h. Statistical analysis was made using a 2x2 factorial arrangement and mean values were compared by Fisher's least significant difference test. Response variables considered were: crude protein (CP), content, ammonia nitrogen as percent of total nitrogen, pH, acetic and lactic acid contents. Addition of molasses increasing ($P < 0.05$) lactic acid content (2.01 vs 7.15%), the crude protein content was about the same (21.8 vs 21.6) whatever the molasses treatment, while reducing ammonia products (2.8 vs 1.9%), pH, (4.7 vs 4.1) and acetic acid (4.8 vs 3.6%). Silages prepared from non-dehydrated forage had higher ($P < 0.05$) CP contents (21.5 vs 20.8%), ammonia products (4.1 vs 2.2%) and acetic acid (5.3 vs 2.6%) and lower pH (4.4 vs 4.7) with less lactic acid (3.5 vs 6.5%). This suggests that combination of molasses and wilting can improve the fermentation quality of *Leucaena leucocephala* silage more than each of them being as a single treatment.

Key Words: *Leucaena leucocephala*, molasses, silage

1434 Prediction of reed canarygrass quality as influenced by N fertilization and maturity. D.J.R. Cherney*, D.R. Dewing, and J.H. Cherney, Cornell University, Ithaca, NY.

The need for more control over forage quality will increase with expanding herd size and increasing individual cow production. Our objective was to develop equations for predicting NDF and CP of first cutting reed canarygrass (*Phalaris arundinacea* L.) using growing degree days base 32°F (GDD32) and Julian date. Previous research has indicated a base temperature of 32°F resulted in better predictions than the 41°F base typically used for forage crops. Pure stands of established reed canarygrass in replicated field plots were fertilized with 0, 56, or 112 Kg of N/ha at the onset of spring growth at four locations in central

1432 MHC and Family Effects of Cellulitis on Lymphocyte proliferation in MHC defined broiler chickens. K. S. Macklin*, R. A. Norton, and S. J. Ewald, Auburn University, Auburn, AL.

Previous work, using avian cellulitis origin *E. coli* isolate (EC-AR1) in broilers demonstrated that the MHC (B type) effects lesion development, specifically that B¹³ was resistant, while B²¹ was susceptible. Other researchers have reported that B¹³ in leghorn chickens has a stronger response than B²¹, when tested with a lymphocyte proliferation assay. The purpose of this study was to use a lymphocyte proliferation assay to: 1. Investigate previously reported leghorn MHC responses in broiler chickens. 2. Use pedigreed matings to determine family effects. 3. Determine proliferation responses in MHC family defined (pre-challenged and challenged) birds to 2.5ug ConA, 1:100 Pokeweed and 1x10⁶ killed *E. coli* (EC-AR1). *E. coli* isolate EC-AR1 has been extensively characterized by this lab in developing two cellulitis models. Matings for the following experiments were designed using B¹³/B²¹ birds (1 male: 10 females). Four experiments were conducted with serological MHC typing at three weeks of age. At week four nine birds of the appropriate MHC (B¹³/B¹³ and B²¹/B²¹) and family types (A-D) were bled and a lymphocyte proliferation assay performed. The following day birds were challenged with a subcutaneous injection of *E. coli* (EC-AR1). Eighteen days post challenge these birds were bled for the proliferation assay, sacrificed and assessed for the presence of cellulitis lesions. Results of lymphocyte proliferation assays closely mimic previously reported results for leghorn type chickens in that B¹³/B¹³ birds produce a stronger response than do B²¹/B²¹ birds. A significant sire family difference was also noted in both proliferative response and development of cellulitis lesions. Results support the hypothesis that MHC plays an important role in influencing lymphocyte response and cellulitis development, while also implying that other yet to be identified genes play a role in these responses.

Key Words: MHC, broiler chicken, lymphocyte proliferation

and western New York over two growing seasons. Plots were sampled beginning Mid-May and continued until the end of May or early June. Regression analysis indicated that GDD32 was the best single predictor of NDF ($R^2=0.608$ and $MSE=31.8$) across all locations, years, and N rates. At each individual location and N rate, however, prediction equations generally had R^2 above 0.90 and MSE generally was below 6. The harvest window, when forage NDF was between 50 and 60% NDF, was predicted using regression analysis. Harvest window ranged from 6 to 11 days. Julian date was the best single predictor of CP, but maturity explained only 50% of CP variation. Data suggest that development and use of prediction equations at individual locations would assist producers in developing harvest strategies to optimize forage quality.

Key Words: Forage quality, Grass, Reed canarygrass

1435 A survey of phytoestrogen activity in Kansas Flint Hills native grass pastures. D.A. Blasi*¹, S.I. Paisley¹, W.V. Welshons², and G.E. Rottinghaus², ¹Kansas State University, ²University of Missouri, Columbia.

Plant-derived estrogens have been implicated as a contributing factor to observed increases in bulling activity and/or reduced efficiency to growth-promoting implants. In an effort to characterize Kansas Flint Hills native grass pastures, the botanical composition and basal cover in three pastures were surveyed using a modified step-point procedure to estimate the incidence of individual plant species. In order to better characterize estrogenic activity, one hundred individual plant species were collected from the three pastures over three sampling periods and frozen. Using estrogen-stimulated growth of MCF-7 cells in tissue culture, all plant samples were subjected to a bioassay screening procedure designed specifically for feed/forage samples. Results are expressed on a zearalenone equivalent (ZE) ppm basis, which reflects the level of zearalenone required to elicit a comparable response. Approximately 85% of the plant species counted were warm season perennial grasses.

Leguminous (native and introduced) plants and forbs represented approximately 7 to 12% of the plant species. Estrogenic activity varied dramatically among the forage species assayed. The highest estrogenic activity was found in Many-Flowered Scurfpea *Psoralea Tenulfior*, *Pursh.* and Ladino Clover *Trifolium repens L.* (average = 43.69 and 10.96 ZE, respectively). Intermediate levels of activity were found in Black medic *Medicago lupulina L.* and Korean lespedeza *Lespedeza stipulacea Maxim.* (average = 5.03 and 8.40 ZE, respectively). This initial survey effort reveals that estrogenic activity exists primarily in native and introduced legumes which compromised only 3 to 4% of the species counted. Consequently, it is not known if the incidence of plant species containing appreciable levels of plant-derived estrogen are sufficient to elicit a detectable response.

Key Words: Phytoestrogen, Buller steer syndrome, Native grass

1436 Changes in nutritive value for bermudagrass hay as affected by initial concentration of moisture and sampling date. J.E. Turner*, W.K. Coblenz, D.A. Scarbrough, K.P. Coffey, D.W. Kellogg, L.J. McBeth, and R.T. Rhein, *Animal Science Department, University of Arkansas.*

Concentrations of moisture $\geq 20.0\%$ are widely known to cause spontaneous heating and associated deleterious effects on forage nutritive value in alfalfa hay, but relatively little is known about these relationships in warm season grasses. 'Greenfield' bermudagrass was packaged in conventional rectangular bales at 21.9, 26.5, and 30.2% moisture (LM, MM, and HM, respectively). Bales made at each concentration of moisture were core sampled at storage (d 0) and after 4, 8, 12, 24 and 65 d of storage. The MM and HM bales accumulated more ($P \leq 0.05$) heating degree days $\geq 35^\circ\text{C}$ than the LM bales. Concentrations of most fibrous and fiber-associated N components increased ($P \leq 0.05$) with time in storage. Concentrations of N increased ($P \leq 0.05$) with time in storage for HM and MM bales, but the concentration of N in the LM bales did not change ($P \leq 0.05$). Concentrations of NDF and ADF and N associated with these fiber fractions were regressed on storage time using a nonlinear model ($Y = \alpha - \beta e^{-kt^2}$); this model was generally effective ($r^2 \geq 0.71$) in describing these relationships. Linear regressions were evaluated that related indices of nutritive value with heating degree days $\geq 35^\circ\text{C}$ and included observations obtained on all six sampling dates from bales made at each concentration of moisture. Heating degree days $\geq 35^\circ\text{C}$ were related ($P \leq 0.0001$) to indices of nutritive value in all cases. However, tests of homogeneity indicated that regression lines were not homogeneous ($P \leq 0.05$) across moisture concentrations at baling for each index of nutritive value. The results of this study demonstrate the negative effects on nutritive value that occur in association with packaging bermudagrass hay at concentrations of moisture $\geq 21.9\%$. Nutritive value of the hay decreased with increasing concentration of moisture at baling throughout the 65-d storage period.

Key Words: Hay Quality, Heating Degree Days, Bermudagrass

1437 Partitioning of nitrogen in bermudagrass forages in response to nitrogen fertilization. J.L. Gunsaulis, W.K. Coblenz*, M.B. Daniels, J.E. Turner, D.A. Scarbrough, J.B. Humphry, K.A. Teague, K.P. Coffey, and N.W. Galdamez, *University of Arkansas.*

During 2000, three harvests of common bermudagrass were made at two sites (Latta and Stephens) in northwest Arkansas to assess the effects of N fertilization on the partitioning of N within cell-soluble and cell-wall fractions of bermudagrass. Ammonium nitrate was applied in split applications totaling 0, 56, 112, 168, 224, 280, or 336 kg N/ha for the year. These totals were reached by applying various combinations of 0, 56, 112, or 168 kg N/ha on the two application dates (28 April and 19 July). Forages were harvested on 30 May, 7 July, and 18 August. On the first harvest date, concentrations of total N increased linearly ($P < .0001$) with fertilization rate at both sites. The overall range for concentrations of N in these forages was 1.78 to 3.53% across both sites. Cell-soluble N increased linearly ($P < .034$) with N fertilization rate at both sites, while cell-wall associated N declined in a linear pattern concurrently. During the second harvest, none of these effects were observed at either site ($P > 0.05$). Following the second application of N fertilizer, concentrations of N on the third harvest date increased with linear ($P < .0001$) and quadratic ($P = .002$) trends at the Latta site and in a linear ($P < .0001$) pattern at the Stephens site. Greater ($P < .047$) proportions of the total N pool became associated with the cell

solubles as fertilization rates increased. On the third harvest date, concentrations of ADIN declined linearly ($P < .011$) with N fertilization at both sites from a maximum of 8.58% to a minimum of 5.90% of the total pool of N in the forage. Averaged over all harvests, N fertilization was positively associated with the proportion of N in the cell solubles and the concentration of N in the total plant. Conversely, the proportions of total N remaining after extraction in neutral and acid detergents declined in response to fertilization with N. All of these overall effects were linear ($P < .023$).

Key Words: bermudagrass, N fertilization, cell wall

1438 Brown midrib-3 corn silage as the major forage for transition cows. H.H.B. Santos*, V.R. Moreira¹, Z. Wu², and L.D. Satter^{1,2}, ¹U.S. Dairy Forage Research Center, USDA-ARS, ²University of Wisconsin, Madison.

The objective was to evaluate brown midrib (bm3) corn silage as a forage for transition cows. Cows (29 primiparous and 83 multiparous) were divided into three groups and balanced according to lactation number and 305d ME milk (multiparous). Two of the three groups were combined for one of two prepartum trts. Cows were placed in trt groups 3-4 wk (mean = 23 days) before their projected calving date. The two prepartum diets contained 65% forage and 35% concentrate, with corn silage (CS) providing 60% and alfalfa silage (alf) 40% of the forage (DM basis). The control CS (Dekalb 512 RR) was stored in two tower silos, and the bm3 (Cargill F657) stored in a bag silo. After calving the three groups, two of which were fed control CS prepartum, were assigned to three postpartum diets for 4-5 wk (mean = 33d). The control diet (control 55 F) contained 55% forage and 45% concentrate, with 58% of the F as control CS and the balance as alf. The second and third postpartum diets contained 65% F, 58% of which was CS and 42% alf. One of these was the control CS (control 65 F) and the other was bm3 CS (bm3 65F). Cows fed control CS prepartum were fed control CS postpartum. Cows were fed a TMR once daily in a tie stall barn. Changes in body weight and body condition score were similar across treatments before and after calving. DMI and post-calving health did not differ between trts. Milk production was similar across trts for primiparous cows, but multiparous cows produced 2 kg/d more with the bm3 trt ($P = .09$).

		Control	Control	bm3	—P <—		
		55F	65F	65F	SEM	CS	F level
DMI, kg/d	Primi	13.0	13.1	12.8	1.1	0.84	0.91
	Multi	16.7	16.9	17.1	0.6	0.78	0.85
Milk, kg/d	Primi	25.0	24.5	24.3	1.6	0.93	0.82
	Multi	33.4	32.9	35.2	1.0	0.09	0.75
Milk fat, %	Primi	4.25	4.41	4.80	0.25	0.29	0.65
	Multi	4.57	4.81	4.81	0.14	0.99	0.24
Milk CP, %	Primi	3.29	3.24	3.28	0.11	0.84	0.74
	Multi	3.35	3.47	3.26	0.06	0.02	0.20

Key Words: Brown midrib, Corn silage, Transition cow

1439 Effects of the heterotrophic bacterium *Lactobacillus buchneri* on preservation of alfalfa and timothy hay. J. Baah*, L. Bos², F. H. VanHerck¹, R. C. Charley³, and T. A. McAllister¹, ¹Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, ²Wageningen University, Wageningen, The Netherlands, ³Biotol Canada Ltd., Niagara-on-the-Lake, ON.

Alfalfa (*Medicago sativa L.*) and timothy (*Phleum pratense L.*) forage were harvested at low (14-18%), medium (18-22%) and high (23-33%) moisture levels (LM, MM, HM) and treated with a heterotrophic bacterium to determine its efficacy for maintaining forage quality during storage. During baling, each forage was treated with *Lactobacillus buchneri* (1.2×10^6 CFU/g fresh forage) as a liquid (LBL) or as a granular preparation (LBG), or with a buffered propionic acid product (10 mL/kg fresh forage, BPA), or was left untreated (control, CON). Triplicate 500-kg bales of each forage \times moisture level were prepared. Internal bale temperatures were monitored continuously for 24 d (alfalfa) or 36 d (timothy), and core samples were collected for analysis 0, 15, 30 and 60 d after baling. After 60 d, voluntary DM intake and in vivo digestibility of chopped CON, LBL and PA hays were determined using 12 Canadian Arcott wethers in a double randomized complete block design experiment. All additives prevented heating, compared with CON, in both

forages at all moisture levels. With LBL and LBG, crude protein contents of HM timothy (12.9% and 12.2%, respectively) were higher ($P < 0.05$) than in CON (10.8%). In MM bales, ADIN content was highest ($P < 0.05$) in CON (32.3% in timothy, 25.0% in alfalfa) bales than in treated bales. The lowest ($P < 0.05$) ADIN in alfalfa (18.6%) occurred with LBG. Yeast counts were lowest ($P < 0.05$) in 60-d MM PA-treated alfalfa. Mold counts were lowest (< 100 CFU/g; $P < 0.05$) with LBL; no molds were detected in 60-d HM timothy with LBL. Dry matter digestibility did not differ ($P > 0.05$) among treatments. Treating timothy hay with LBL increased ($P < 0.05$) DM intake by sheep by 28.6% (to 1.33 kg/d) over CON, and by 19.7% over PA-treated timothy. The heterolactic bacterium *L. buchneri* can substantially improve the nutritive value of high moisture alfalfa and timothy hays.

Key Words: *Lactobacillus buchneri*, Forage hay, Nutritive value

1440 Effects of maturity and N fertilization on in vitro biohydrogenation of timothy linolenic and linoleic acids. H. Boufaied*¹, P.Y. Chouinard¹, G.F. Tremblay², H.V. Petit³, R. Michaud², and G. Blanger², ¹Université Laval, QC, Canada, ²Agriculture and Agri-Food Canada, Ste-Foy, QC, Canada, ³Agriculture and Agri-Food Canada, Lennoxville, QC, Canada.

Up to 75% of total fatty acids (FA) present in forage complex lipids are α -linolenic (C18:3) and linoleic (C18:2) acids. In the rumen, these polyunsaturated FA are liberated by lipolysis, and hydrogenated by microorganisms. Our objective was to determine the effect of maturity (stem elongation, early heading, late heading, and early flowering) and N fertilization (0 and 120 kg N/ha) on in vitro biohydrogenation of timothy (*Phleum pratense* L.) C18:3 and C18:2 FA. Timothy samples were taken during the primary growth of the first production year from a 2 × 4 factorial experiment in a split-plot design with four replications. Forage samples were dried and ground. Fatty acids were methylated using methanolic HCl, and analyzed by gas chromatography. Concentrations of C18:3 and C18:2 decreased linearly with maturity and increased with N fertilization ($P < 0.05$). Dried samples were incubated with rumen fluid at 39°C for 0, 3, 6, 9, 24, and 36 hours. After each incubation period, the samples were lyophilized, methylated, and analyzed for FA. The C18:3 and C18:2 concentrations decreased with incubation time (t) according to this model: C18:3 and C18:2 = $i + b(e^{-ct})$. The hydrogenation rates (c) of the potentially hydrogenable fraction (b) were not affected by maturity and N fertilization. The non hydrogenable fractions (i) of C18:3 and C18:2 increased with N fertilization ($P < 0.05$) but they were not affected by maturity. The b fraction, the effective hydrogenation [EH = $b/(c+(c+0.06))$], and the bypass (BP = $i + b \# EH$) of C18:3 and C18:2 were higher in timothy harvested at stem elongation and decreased linearly with maturity ($P < 0.05$). Nitrogen fertilization increased the b fraction, the EH, and the BP of C18:3, and it also increased the BP of C18:2 ($P < 0.05$). The ruminal BP of C18:3 and C18:2 would be respectively 75 and 33% higher for timothy harvested at stem elongation and fertilized with 120 kg N/ha as compared with timothy harvested at early flowering with no N fertilization; this is mainly explained by the higher C18:3 and C18:2 concentrations in well fertilized timothy at early stage of maturity.

Key Words: Timothy, Growth Stage, Fatty acids

1441 Effects of ensiling carbohydrates with wheat straw and 4% urea. T.V. Nguyen*, M.J. Montgomery, and C.J. Richards, University of Tennessee, Knoxville, TN.

Two experiments were conducted to evaluate protein fractions of wheat straw ensiled with urea and additional carbohydrate sources. In the first complete randomized design experiment, 40 g of dried molasses, corn meal, rice mill or tapioca were added to 1000 g of wheat straw, 40 g urea and 1000 g water. The combination was ensiled anaerobically for 21 days before grinding for chemical analyses. Wheat straw treated with carbohydrate had a higher ($P < 0.01$) CP content than the control. The CP contents were 8.33, 7.99, 7.74, 7.58 and 7.02% for dried molasses, corn meal, rice mill, tapioca and control treatments, respectively. Soluble nitrogen contents measured by direct distillation were lowest ($P < 0.05$) for dried molasses (1.76) and corn meal (1.88%), intermediate for tapioca (1.96%) and highest ($P < 0.05$) for rice mill (2.27%) and the control (2.06%). Insoluble CP was highest ($P < 0.05$) in dried molasses (7.93%) and corn meal (7.12%) treatments, intermediate in rice mill (4.38%) and tapioca (4.55%) treatments and lowest ($P < 0.01$)

in the control (3.02%). The second experiment was a randomized complete block design. No additional carbohydrate or 3 levels (40, 60, or 80 g) of dried molasses or corn meal were added to 1000 g of wheat straw, 40 g urea and 1000 g water before ensiling and analyses as in the first experiment. Straw ensiled with dried molasses or corn meal had a higher ($P < 0.05$) CP content (avg 8.69 and 8.88%, respectively) than control (7.46%). Level of corn meal addition did not affect ($P > 0.10$) the CP content of ensiled straw, while addition of 80 g of dried molasses resulted in higher ($P < 0.01$) CP concentrations than the addition of 40 g of dried molasses. An addition of carbohydrate into 4% urea treatment of wheat straw could increase both CP content and insoluble fraction of protein of silo.

Key Words: Urea, Crude Protein, Wheat straw

1442 Production and quality of Buffel grass (*Cenchrus ciliaris*) grown and utilized under different conditions in Northern Mexico. C Lizarazo-Ortega, H Bernal-Barragan, and E Gutierrez-Ornelas*, Facultad de Agronomía, UANL, Marín N.L. Mexico.

The objective of this study was to determine the effect of type and intensity of utilization on DM production and quality of Buffel grass (*Cenchrus ciliaris* cv Nueces) grown under natural rainfall or irrigation conditions in Northern Mexico. Sixteen plots (64 m² each) were grazed by Charolais cattle in order to achieve a 50% (G50) or 75% (G75) utilization of DM production. Eight plots (40 m² each) were hand clipped to use 50% (H50) of DM. Half of the experimental plots received only natural rainfall (yearly average = 583 mm), the rest of the plots were additionally irrigated with 70 mm after each utilization, which occurred in September and November 1999, and in June and November 2000. Production and quality variables were analyzed under a randomized block design. Year, type and intensity of utilization and irrigation were included in the model as main factors. Yearly forage crop was 22% higher ($P < 0.05$) for G50 than H50 (1893 vs 1541 kg DM/ha), without affecting ($P > 0.05$) residual forage (1421 vs 1213 kg DM/ha). No differences ($P < 0.05$) in forage crop were found between G50 and G75, after 2 years of study the available forage in G75 plots was similar to G50 (3363 vs 3253 kg DM/ha). Irrigation increased forage crop by 15% ($P = 0.13$) compared to those plots under natural rainfall conditions (1195 vs 1720 kg DM/ha). No differences ($P > 0.05$) due to type and intensity of utilization were found in CP, NDF, and ADF content of Buffel grass, but ADF was increased ($P < 0.05$) in irrigated plots. In vitro DM digestibility was higher ($P < 0.05$) in H50 than in G50 and G75 grazed plots (56.7, 54.7 and 53.3%). Buffel grass production was increased by grazing, but IVDMD was better in hand clipped forage.

Key Words: Buffel grass, Grazing intensity, Forage quality

1443 Effect of Mott Dwarf Elephant grass (*Pennisetum purpureum*) silage on dry matter intake, milk production, digestibility and rumen characteristics in Nili-Ravi buffaloes. M. Q. Bilal, M. Abdullah*, and M. Lateef, University of Agriculture, Faisalabad, PAKISTAN 38040.

The effect of Mott grass (*Pennisetum purpureum*) silage was determined on the performance of 12 lactating Nili-Ravi buffaloes in a Randomized Complete Block Design (RCBD) with three replicates. The four treatments included; 100% green chop (control, T₁), 2/3 green chop and 1/3 Mott silage (T₂), 1/3 green chop and 2/3 Mott silage (T₃) and 100% Mott silage (T₄). The combination of green chop and silage in the treatments T₂ and T₃ was on dry matter basis. Average daily dry matter intake was higher (16.83 kg/d) in buffaloes on T₃ as compared to those fed the control (13.52 kg/d), T₂ (13.96 kg/d) or T₄ (12.00 kg/d) diets. The intake of crude fiber had the same trend as in case of dry matter for different treatments. Buffaloes fed the combinations of green chop and silage produced more 4% FCM than those fed either green chop or silage alone (10.03 and 11.30 vs. 8.23 and 8.47 kg/d) for T₂ and T₃ vs. T₁ and T₄, respectively. Different treatments had no effect on the composition of milk. The digestibility of dry matter and crude fiber was significantly greater ($p < 0.05$) in buffaloes fed the combination diets T₂ and T₃ (65.1 and 65.0%, and 52.4 and 52.8%) as compared to T₁ and T₄ (62.6 and 60.8%, and 50.7 and 51.0%) for dry matter and crude fiber respectively. Increased digestibility may be attributed to some positive associative effect between the two forage sources. The difference in rumen pH (6.69 to 6.72) for all the four experimental diets appeared to be non-significant. However, rumen ammonia nitrogen

was higher ($p < 0.05$) in buffaloes fed the green chop or the silage alone (25.0 and 24.3 mg/100ml, respectively) than in those fed the combination of the two forage sources (16.7 and 16.5 mg/100ml) for T_2 and T_3 , respectively.

Key Words: Mott grass, Buffaloes, Milk production, Digestibility

1444 Assessment of forage quality and DM digestion kinetics for wheat forage as affected by harvest technique and sampling date. W.K. Coblenz, K.P. Coffey, J.E. Turner, D.A. Scarbrough, J.B. Humphry, J.V. Skinner, and D.W. Kellogg, *University of Arkansas*.

A trial was initiated in September of 1999 to assess the effects of harvest techniques and sampling dates on DM digestion kinetics and forage quality of wheat forage. "Delta King 9027" soft-red winter wheat was established at the Forage Research Area in Fayetteville. Wheat forage was grazed lightly throughout the fall to control growth. Forages were harvested on three dates in the spring, which corresponded to vegetative, mid-elongation, and boot stages of growth (6 March, 27 March, and 11 April, respectively). Sampling techniques evaluated on each date included three clipping techniques (whole plant, random pluck, and top half) and two evaluations of masticates (oven dried at 50°C or freeze dried). Concentrations of total N, NDF, ADF, hemicellulose, cellulose, and lignin were affected ($P < .0001$) by the harvest technique and sampling date main effects. In all cases, there was an interaction ($P \leq .0002$) of main effects. Digestion kinetics of DM for these forages were evaluated by the in situ technique using five ruminally fistulated (393±54-kg) crossbred steers. The potential extent of DM degradation was affected ($P < .0001$) by both main effects and their associated interaction. Harvest technique and sampling date both affected ($P < .0001$) degradation rate of DM; but their associated interaction did not ($P > .05$). Averaged over three sampling dates, rates of degradation for freeze-dried masticate (.088/h) were greater ($P < .05$) than all other treatments. Clippings of the top half of the canopy (.076/h) and oven-dried masticate (.070/h) had faster ($P < .05$) degradation rates than did the random-pluck (.055/h) and whole-plant (.055/h) clipping treatments. Lag time was affected ($P = .027$) by harvest technique only; lag times for freeze-dried masticate (.88 h) were shorter ($P < .05$) than all other treatments (mean = 1.65 h). Estimates of effective degradability of DM were high for all treatments (overall mean = 73.3%); however, main effects and their associated interaction were all highly significant ($P < .0001$).

Key Words: wheat forage, degradation kinetics, forage quality

1445 Physical and chemical characteristics affecting in vitro digestibility of corn silages of different particle sizes. G. Ferreira*¹ and D.R. Mertens², ¹*Universidad Catolica Argentina, Buenos Aires*, ²*US Dairy Forage Research Center, Madison, WI*.

Nutritive evaluation of corn silage is complicated by interactions between grain and stover and between chemical composition and physical form. Thirty-two diverse corn silages were selected to study the relationships among in vitro digestibility and silage characteristics. Dried silages were incubated whole and after grinding (4 and 1 mm) for 24 h using in situ bags in a rotating jar in vitro system. Ranges in variables were: DM, 19-48%; CP, 6-12%; starch, 12-36%; aNDF, 30-56%; ADF, 18-35%; ADL, 1.2-3.5%; mean particle size (PS), 2.1-7.3 cm; in vitro DM disappearance (IVDMD) of whole silage, 45-77%; IVDMD 4-mm, 61-79%; IVDMD 1-mm, 59-82%; IV true DM disappearance 1-mm, 68-85%; and IV NDF disappearance 1-mm, 38-57%. Corn kernels and fragments >1/4 kernel were retained on sieves with apertures >4.75 mm. The proportion of total DM recovered as starch in kernels and fragments >4.75 mm ($ST > 4.75$) ranged from 2 to 33%. Total starch was related to nonfibrous carbohydrate (NFC) calculated by difference: starch = $-6.0 + .76(\text{NFC})$, $R^2 = 0.87$; ADF = $0 + .61(\text{aNDF})$, $R^2 = 0.84$; and grain DM = $36.7 + .56(\text{silage DM})$, $R^2 = 0.77$. Individual relationships of aNDF, ADF, or ADL with IVDMD 4-mm or 1-mm yielded R^2 ranging from 0.59 to 0.76, with ADF having the highest R^2 . These R^2 were from 0.21 to 0.40 for IVDMD of whole silages. The relationship of aNDF with IVDMD 4-mm or 1-mm was improved by the addition of ADL suggesting that both the amount and characteristics of fiber are important: IVDMD 1-mm = $96.4 - .26(\text{aNDF}) - 3.26(\text{ADL})$, $R^2 = 0.73$. The R^2 between aNDF and IVDMD of whole silage was improved to 0.64 by the addition of $ST > 4.75$ and ADL. The relationship between IVDMD of 1-mm and whole silage was poor $R^2 = 0.29$, and was improved ($R^2 > 0.74$)

by the addition of $ST > 4.75$, PS, ADL, and CS DM. It is concluded that fiber characteristics impact the ultimate digestion of finely ground corn silages. In addition, particle size and the proportion of DM recovered as starch from kernels and large fragments affect digestion of whole silages.

Key Words: Corn silage, Digestibility, Fiber

1446 Factors affecting the measurement of forage digestibility. W. A. Scheer*, D. M. Chatman, and J. N. Spain, *University of Missouri, Columbia, MO*.

The objective of this study was to evaluate the factors affecting the measurement of the digestibility of various types of forages as related to accurate prediction of relative feed value. Forage samples used in this experiment were obtained from the 2000 Missouri State Fair hay contest and included alfalfa (ALF; n=29), clover (CLV; n=6), cool (CSG; n=12) and warm (WSG; n=3) season grass, and mixed alfalfa-grass hays (MIX; n=6). Representative core samples from two bales of each forage submitted were collected and composited. Samples were ground (5 mm) and analyzed for DM, CP, NDF, and ADF using standard analytical procedures. Samples were then digested in situ in two ruminally fistulated cows fed identical lactation diets. Cow 1 was 105 DIM, second parity, and cow 2 was 334 DIM, fifth parity. For each cow, triplicate 5 g samples of each forage were placed into individual 10 cm x 20 cm Dacron polyester bags with a mean pore size of $50 \pm 15 \mu\text{m}$. Incubation times were 0 and 24 hours. Chemical analysis of forages yielded expected differences and were as follows: ALF: DM 88.0%; CP 21.9%; NDF 42.4%; ADF 29.1%; CLV: DM 88.7%; CP 16.3%; NDF 46.6%; ADF 31.0%; CSG: DM 89.9%; CP 12.4%; NDF 66.0%; ADF 34.0%; WSG: DM 90.2%; CP 13.6%; NDF 75.6%; ADF 34.2%; MIX: DM 88.4%; CP 19.3%; NDF 47.9%; ADF 31.0%. Average 24-hour in situ dry matter digestibility was different (ALF 61.0%^a; CLV 60.2%^a; CSG 53.6%^b; WSG 39.0%^c; MIX 57.8%^a). Furthermore, regression analysis described different relationships between ADF and in situ degradation between forages, as well as differences in the in situ digestion of the same forages between cows. In summary, these results point out the need to standardize the in situ conditions used to describe the DM digestibility of forages.

Key Words: Forages, Digestibility, Relative feed value

1447 Comparison of three methods to estimate digestible NDF of forages. D. K. Combs*¹ and P. Berzaghi², ¹*University of Wisconsin, Madison*, ²*University of Padova, Italy and U.S. Dairy Forage Research Center, Madison, WI*.

The objective of this study was to compare NDF digestibility estimated from in vitro NDF digestion kinetics, in vitro NDF degradation at single time points (24h and 48h) and the empirical equation used in the NRC Nutrient Requirements of Dairy Cattle (2001). Grass, legume and grass-legume hays and silages (n=99) were analyzed for DM, NDF, lignin, and NDFICP. Truly digestible NDF was estimated as $0.75 \times [(\text{NDF} - \text{NDFICP}) \times \text{lignin}] \times [1 - (\text{lignin}/(\text{NDF} - \text{NDFICP}))^{0.667}]$. Dried, ground forages (0.5 g) were incubated in 50 ml of 1:4 medium of rumen fluid and buffer (Goering and Van Soest, 1970) for 0, 3, 6, 9, 12, 24, 36, and 48 h, and the residues analyzed for NDF. Percentage of residual NDF versus incubation time was fitted by a non-linear least squares estimating procedure to a first order model with an indigestible fraction and a discrete lag time before digestion. Kinetics parameters lag time (lag), potentially degradable NDF (Fraction B), rate of Fraction B disappearance (kd), and the asymptotic estimate of indigestible NDF (fraction C), were estimated. Estimated NDF digestibility (% of NDF) at maintenance intake was estimated by assuming a fractional NDF passage rate (kp) of 0.02/hr. NDF digestibility at 24h was similar to the kinetic estimate of NDF digestibility at maintenance and the two estimates were correlated ($r^2 = .68$). However, NDF digestibility at maintenance was more highly correlated to the single time point at 48h ($r^2 = .78$). The empirical and kinetic estimates of NDF digestibility were also similar, but the correlation between the empirical estimate and the single timepoint at 48 h was lower ($r^2 = .42$).

Item	Mean	S.D.	Min.	Max.
NDF, % DM	43.1	5.8	32.1	57.5
Lag, h	1.8	1.5	0.0	7.0
Fraction B, % NDF	52.8	12.4	34.2	100.0
kd, h ⁻¹	0.01	0.05	0.01	0.27
DNDF (kinetic), % NDF	40.0	7.3	26.5	58.2
DNDF (24h), % NDF	44.1	10.8	20.1	72.2
DNDF (48h), % NDF	50.5	10.7	28.1	74.7
DNDF (empirical), % NDF	38.2	5.0	25.1	48.9

Key Words: Forage, Digestibility, NDF

1448 Evaluation of the influence of host animal diet and forage type on the ruminal degradation of grass silage and intercropped pea-wheat silages. A.T. Adesogan*¹, M.B. Salawu¹, and R.D. Dewhurst², ¹IRS, University of Wales, Aberystwyth, SY23 3AL UK, ²Institute of Grassland and Environmental Research, SY23 3EB, UK.

This study compared the rumen degradability of grass silage and intercropped pea-wheat silages in order to understand why dairy cows fed a short straw, pea-wheat intercrop needed only half as much concentrates to produce the same amount of milk as the grass silage (Adesogan et al., 2000). The effect of host animal diet on rumen degradation was also examined. Two spring sown intercrops of wheat and tall (cv. Magnus; MW) or short straw (cv. Setchey; SW) peas were compared with grass silage (GS). The silages were ruminally incubated in three dry Friesian cows in a 3x3 change over design. Degradability was measured in the last week of each period after two weeks of adaptation. Each forage was incubated in quadruplicate in cows fed that forage alone, at maintenance, for 4, 8, 16, 24, 48, 72, and 96 h. The kinetic degradation parameters were described with the exponential model ($D = A+B(1-\exp(c(t-tL)))$) where A = washing loss, B = potentially degradable insoluble fraction, c = fractional degradation rate and tL = lag time. Effective degradability (ED) was calculated using a fractional outflow rate (k) of 0.05/h. To study the effect of host animal diet, four replicate samples of each forage were also incubated for 24 or 48 h in the rumen of cows fed on the other forages in each period. Although A was highest in MW (P<0.05), SW and GS had similar values. The other DM degradation parameters and the N loss after 24 or 48 h were unaffected by forage type. Over 90% of N and 73% of starch disappeared from SW within 24 h. NDF loss was consistently higher in GS. Host diet did not affect the ruminal degradation in the intercrops but affected (P<0.05) the DM, N, starch and NDF degradation of GS. In conclusion host diet only affected the degradation of grass silage, hence grass silage fed sheep can be used to generate accurate degradability data on bi-crops. The rapid degradation of the appreciable starch and N in the intercrops (Adesogan et al., 2000) suggests that they could synchronously supply energy and protein to the rumen and thereby enhance microbial protein production. Reference Adesogan, TA, Salawu, MB and Dewhurst, RD 2000. Concentrate requirement for dairy cows halved with pea-wheat bi-crops. Proc. Res. Conf. Brit. Grassl. Soc. Aberdeen.

Key Words: Rumen degradation, Intercropping, Silage

1449 Eastern gamagrass digestion kinetics and forage quality as influenced by harvest management. D.J.R. Cherney*¹, P.R. Salon², and J.H. Cherney¹, ¹Cornell University, Ithaca, NY, ²USDA-NRCS, Big Flats Materials Center, Big Flats, NY.

Objectives were to evaluate the digestion kinetics and forage quality of eastern gamagrass (*Tripsacum dactyloides* L.) as influenced by date of initial harvest and second-cutting interval (4-, 5-, and 6-wk). Gamagrass, variety 'Pete', was harvested in 1997 and 1998 from triplicate plots of an established stand at Big Flats, New York. Plots were fertilized with 112 kg of N/ha. Crude protein, digestible NDF and in vitro true digestibility decreased (P < 0.05) with increased cutting interval in both years. Mean crude protein was clearly reduced for the 6-wk second cutting interval, regardless of initial harvest date. There were interactions (P < 0.05) between initial cutting date and second cutting intervals for NDF, ADF and lignin both years. Interactions between initial cutting dates and second cutting dates were not significant (P > 0.05) for potentially digestible fiber (Do), indigestible fiber (I), and rate of fiber digestion (k). Gamagrass cut at the 6-wk cutting interval had lower Do (48.2 1.7% vs 50.5 0.6% and 50.3 0.6% vs 55.3 1.5% for 1997 6- vs 4-wk and 1998 6- vs 4-wk, respectively) and higher I (23.0 2.5% vs

20.2 1.7% and 21.7 2.2% vs 17.7 2.2% for 1997 6- vs 4-wk and 1998 6- vs 4-wk, respectively) than the 4-wk cutting interval, regardless of initial harvest date. This was generally true for k as well. Forage quality and digestion kinetics of gamagrass harvested at 5-wk cutting intervals tended to be intermediate between 4- and 6-wk cutting intervals. This data, coupled with yield data suggest that a 5-wk cutting interval is optimal.

Key Words: Eastern gamagrass, Forage quality, Digestion kinetics

1450 Nutrient digestibility and bacterial protein synthesis of a pasture diet in response to increased level of dietary brassica in continuous culture. K. J. Soder*², L. A. Holden¹, S. R. Hershey¹, and M. R. Long¹, ¹The Pennsylvania State University, PA, ²USDA-ARS, University Park, PA.

A dual effluent continuous culture system was used to investigate the effect of inclusion of four levels of brassica in a pasture diet on nutrient digestibility and bacterial protein synthesis and efficiency. Four fermenters were fed three times daily an orchardgrass (*Dactylis glomerata* L.) pasture diet containing either 0%, 15%, 30%, or 45% brassica (*Brassica rapa* L.). Four 10-d periods were conducted, with 7 d for adaptation and 3 d for sample collection in each period. Ruminal pH was recorded at each feeding, and solid and liquid effluent was collected during the last 3 d of each period. Bacterial pellets were harvested at the end of each period. Pasture and effluent samples were analyzed for CP, DM, OM, in vitro DM digestibility, NDF, ADF, and TNC. Bacterial samples were analyzed for DM, OM, CP, and purine content. Bacterial yield and N flow were calculated based on the purine and N content of the effluent and bacterial samples. NDF digestibility increased when brassica was included at 45% of the diet DM compared with the other treatments (70.6, 68.37, 71.6, and 76.0% DM for 0, 15, 30, and 45% brassica, respectively). Valerate increased in a linear fashion with increased brassica inclusion (2.17, 2.53, 2.82, and 3.06, M/ml, respectively), but other VFA's were not significantly affected by diet. Bacterial protein synthesis increased in a linear fashion with increased brassica (44.3, 46.6, 48.1, and 50.2% CP, respectively). Ruminal pH, non-NH₃ N flow and bacterial efficiency were not affected by treatment. This study suggests that brassicas may be utilized in a pasture diet as an alternative forage source to increase NDF digestibility and bacterial protein synthesis, but these increases did not translate into increased bacterial efficiency.

Key Words: Pasture, Brassica, Microbial Protein

1451 Crop processing and chop length effects in brown midrib corn silage on chewing activity and mean particle size of silage and masticates. E. C. Schwab* and R. D. Shaver, University of Wisconsin, Madison, WI.

Brown midrib-3 corn silage was harvested using a crop-processing harvester with rolls set at 2 mm clearance (PR) or unprocessed (UP). Theoretical lengths of cut (TLC) were 13 and 19 mm for UP corn silage treatments (13UP and 19UP), and 19 and 32 mm for the PR corn silage treatments (19PR and 32PR). Mean particle size of 13UP, 19UP, 19PR, and 32PR corn silage treatments were 9.7, 12.0, 9.7, and 10.8 mm, respectively. Twenty-four Holstein cows were used in a replicated 4 X 4 Latin square design with 28-d periods. Orthogonal contrasts were used to evaluate TLC (13UP vs. 19UP and 19PR vs. 32PR) and crop processing (19UP vs. 19PR) effects. Increasing TLC increased (P < 0.05) eating time (min/kg DMI; 9.2 for 13UP vs. 9.9 for 19UP) for UP but not PR. Crop processing of 19 mm TLC silage reduced (P < 0.05) eating time (min/d and min/kg DMI; 244 and 9.9 for 19UP vs. 224 and 8.9 for 19PR, respectively). Rumination time (min/kg DMI) was higher (P < 0.05) for 19UP than 13 UP (15.7 vs. 14.6). Crop processing increased (P < 0.02) and longer TLC of PR silage reduced (P < 0.005) rumination min/kg of NDF intake. Total chewing times (min/d) were unaffected by treatments, but 19UP was greater (P < 0.01) than 13UP when expressed as min/kg DMI (25.6 vs. 23.8). Masticate boluses from respective corn silage treatments were collected at the cardia of 8 ruminally cannulated cows, and mean particle size (MPS) was determined via wet sieving (MPS of 6.4, 7.6, 5.8, and 7.1 mm for 13UP, 19UP, 19PR, and 32 PR, respectively). Increasing TLC had no effect on masticate MPS, silage MPS minus masticate MPS (DIFF), or percent MPS reduction. Crop processing reduced (P < 0.05) masticate MPS (3.8 mm for 19UP vs. 3.2 mm for 19PR) and DIFF (3.7 mm for 19UP vs. 2.6 mm for 19PR). Small differences among treatments in MPS of corn silage masticates may partially explain the lack of response in lactation performance

trials to increased chop length. Crop processing of 19 mm TLC silage reduced eating time and mean particle size of silage and masticates.

Key Words: corn silage, mean particle size

1452 N-alkanes as markers for estimation of dry matter intake and diet composition in steers consuming all-forage or forage-concentrate diets. S.A. Moshtagh Nia^{*1}, K.M. Wittenberg¹, and W. Chen², ¹University of Manitoba, Winnipeg, MB, ²Agriculture and Agri-Food Canada, Brandon, MB.

Eight Holstein steers weighing approximately 208 kg were assigned to four dietary treatments in a three period cross over design to compare the alkane-based and chromium/in vitro-based procedures with the total fecal collection technique relative to estimating of dry matter intake (DMI) and diet composition for forage or forage:concentrate based diets. The four dietary treatments were 1) pure meadow brome grass hay (B); 2) 1/2 B + 1/2 alfalfa hay (BA); 3) 1/2 B + 1/2 barley grain (BB); and 4) 1/4 B + 1/4 alfalfa hay + 1/2 barley grain (BAB). The two types of hay were chosen to achieve a wide range of hydrocarbon intake. Appropriate portions of forages and grain were mixed as a total mixed ration and fed in two equal portions twice daily at 2.5% of body weight. Two controlled release capsules, one containing n-alkanes (C₃₂ and C₃₆) and other chromic oxide were placed into the steer reticulo-rumen by oral administration on day 1 of each period (30 days). Total fecal output was collected twice daily from day 8 to 14 of each period to establish the fecal recovery of chromium and the alkanes. Recovery of alkanes was also calculated by in-vitro digestion of individual feed samples. Fecal recovery of the natural alkanes, C₃₁ and C₃₃, was low, ranging from 59.5 to 73.3%, whereas the range in fecal recovery of the dosed alkanes, C₃₂ and C₃₆, was 83.3 to 95.5%, and of chromium was 82.7 to 95.8 across the diets. The estimated DMI was similar across all diets using the C₃₁/C₃₂ and C₃₃/C₃₂ alkanes; however, the estimated DMI using C₃₁/C₃₂ was significantly (P < 0.05) lower compared to total collection or chromium/in-vitro methods. The use of least-squares to estimate ingredient proportions in the diet using n-alkanes is excellent when marker recovery values from total collection are used. Estimates of ingredient proportions in the diet were less reliable when in-vitro digestion was used for n-alkane recovery estimates.

Key Words: Alkanes, Chromium, Dry matter intake

1453 Estimation of forage intake of lactating dairy cows on pasture using n-alkanes. H. M. Froebe^{*}, K. M. Wittenberg, and S. A. Moshtagh Nia, University of Manitoba, Winnipeg, Canada.

The objective of this study was to determine the forage intake of lactating dairy cows on pasture using the n-alkane marker technique when fed at different levels of concentrate supplementation. In two separate trials, fifteen primiparous Holstein cows weighing approximately 552 ± 49 kg were randomly assigned to three dietary treatment groups according to milk production (33.1 ± 5.0 kg/day) and days in milk (168 ± 89). The three dietary treatments consisting of concentrate supplement were fed at 20% (L), 35% (M), and 50% (H) of pre-trial total dry matter intake (DMI). The supplement was fed in equal portions at each milking

(AM and PM). Cows grazed a primarily orchardgrass (*Dactylis glomerata*) pasture and were moved to a new section of the pasture daily. A controlled-release capsule containing n-alkane (C₃₂ and C₃₆) was placed into the cow reticulo-rumen by oral administration. Fecal grab samples were collected twice daily at milking for a seven day period, starting on the seventh day post administration. Milk production was 21.8, 26.4 and 30.5 ± 1.6 kg/day for the L, M, and H groups respectively. The L group had significantly lower (P < 0.05) milk production compared to the M and H groups. The estimated forage DMI was calculated using the C₃₁/C₃₂ and C₃₃/C₃₂ alkane ratios. The estimated forage DMI using C₃₃/C₃₂ had higher intake of 15.1, 13.3, and 11.0 ± 1.0 kg/day compared to using C₃₁/C₃₂ with intake of 14.0, 12.2, and 10.0 ± 1.0 kg/day for L, M, and H respectively. However, with both ratios, the L treatment had significantly (P < 0.05) higher forage DMI estimates than the H treatment. The estimated total DMI using C₃₃/C₃₂ was similar across all dietary treatments with an average value of 19.4 ± 1.1 kg/day, reflecting 3.5 ± 0.2% of body weight, whereas, the estimated DMI using C₃₁/C₃₂ had an average value of 18.4 ± 1.0 kg/day, reflecting 3.3 ± 0.2% of body weight. Daily fecal output estimates using C₃₆ were similar for all dietary treatments averaging 5.9 ± 0.3 kg/day (DM basis). It was concluded that at lower level of concentrate feeding, the cows compensated by higher level of forage intake on pasture.

Key Words: N-alkanes, Pasture intake, Dairy cow

1454 Evaluation of cultivates of alfalfa (Medicago sativa L.) by in situ degradability technique. E. C. J. Sales, A. R. Evangelista^{*}, R. A. Santos, and J. C. Teixeira, Universidade Federal de Lavras, Minas Gerais, Brazil.

Fifteen cultivates of alfalfa (*Medicago sativa* L.): Alpha 200, SW 8210, High, Rio, Monarca SP INTA, Victria SP INTA, Semit 711, P 30, P 205, F 208, Florida77, MH 4, Br 1, Br 2 and Creole, were studied with to evaluate the ruminal degradability of the dry matter (DM), crude protein (CP) and neutral detergent fiber (NDF). Samples of each cultivate they were placed in nylon bags and incubated in the rumen of cows for 0, 6, 12, 24, 48, 72 and 96 h. The disappearance of the nutrients data (DM, CP and NDF) in the bags, were submitted to the analysis of non linear regression of Gauss-Newton, being used the model $DP = a + b(1 - \exp(-c \cdot t))$, to potential degradability and $DE = a + ((b \times c)/(c+k))$, to effective degradability. Assuming rate of passage of 5 %/h, there was not difference (P > 0.05) between cultivates to dry matter effective degradability. Significant values (P < 0.05) were found to CP and NDF effective degradability, standing out cultivate Loud, Monarch SP INTA, Victria SP INTA, Semit 711, P 30, P 205, F 208, Florida 77, MH 4, Br 1, Br 2 and Creole. To the degradation rate of CP was not verified significant effect (P > 0.05). The largest degradation values of CP, they can be attributed to the largest efficiency of degradation of N for the microorganisms, once the animals received balanced diet with the degradation rate between cultivates. To NDF, there were variations (P < 0.05) in the degradation rate between cultivates. The soluble fraction from CP and NDF differed between cultivates; the difference found in those cultivates can not be attributed to the handle of the samples and consequent bedding of particles, and also due the presence of soluble components (starch, pectin).

Key Words: Alfalfa, Degradability, Cultivate

ASAS/ADSA Ruminant Nutrition: Fat, Protein, Intake, and Feedlot

1455 Effect of Housing and Fat Supplementation on Reproduction and Productivity of Holstein Cows in early Lactation . S.L. Boken^{*}, C.R. Staples, L.E. Sollenberger, W.W. Thatcher, and P.J. Hansen, University of Florida, Gainesville, FL.

The objective of this trial was to investigate the effects of feeding a soybean oil refining byproduct (SORB) on estrus behavior and productivity of early postpartum Holstein cows managed in a free stall barn or in an intensive rotational grazing system of cool season rye-ryegrass pasture. Multiparous Holstein cows (n=35) were assigned randomly at calving to one of four treatments arranged in a 2 by 2 factorial design. The SORB was suspended in a molasses slurry (30% of slurry DM). The SORB was mixed into a TMR (2% of diet DM) for cows in the barn and into the grain supplement (3.9% of DM) for cows on pasture. Control cows were fed liquid molasses without SORB. Cows on pasture grazed in groups of three and were fed supplement twice daily at a rate of 1

kg/ 2.5 kg of milk produced. During the first 14 wk of lactation, milk production of cows kept in free stalls peaked higher (41.8 vs. 38.1 kg/d) and was more persistent than cows kept on pasture (housing x time, P = 0.03). Average milk fat content was greater for barn-fed cows (3.39 vs. 3.16%, P = 0.02) but average milk protein content was unchanged (2.98 vs. 2.89%). Fat supplementation did not affect milk production or composition. Cows on pasture relied more on body reserves to help support milk production as plasma NEFA concentrations peaked higher (772 vs. 579 mEq/L) and later postpartum (wk 4 vs. 1) (housing x time, P = 0.002). Production of microbial nitrogen as estimated by allantoin and creatinine analyses of spot samples of urine was unaffected by treatment (326 g/d, SE = 30). Estrus activity was recorded using the HeatWatch[®] estrus detection system. Cows not detected in estrus (n = 14) were assigned 98 DIM as the number of days to first estrus and this did not differ among treatments (69 DIM, SE = 6). When only

cows that exhibited estrus were analyzed ($n = 21$), number of days to first estrus was similar (50 DIM, SE = 6) and length of first estrus was similar (291 min, SE = 77); however number of mounts during the first estrus (7.7 vs. 4.7) was greater ($P = 0.05$) for cows kept on pasture. Cows managed on pasture produced less milk of lower fat content, had higher concentrations of plasma NEFA, and demonstrated more intense estrus activity during the first 14 wk postpartum.

Key Words: pasture, fat, reproduction

1456 Increasing the concentration of beneficial fatty acids in lamb muscle. K Nuernberg¹, S Grumbach², K Ender¹, and G Nuernberg¹, ¹Research Institute for the Biology of Farm Animals, ²State Institute of Agriculture and Fishery M/V.

The objective of the study was to optimize the production of high quality sheep meat under different production systems and to increase the concentration of n-3 polyunsaturated fatty acids (PUFA) in muscle of lambs. Thirty four male crossbred lambs (Texel x Bleu du Maine) with an initial live weight of 20 kg were used in the experiment. The lambs were randomly divided into three groups (group 1: weaning lambs fed intensively with concentrate, group 2: suckling lambs kept on pasture, group 3: weaning lambs kept on pasture). Animals were slaughtered at an average live weight of 40 kg. The carcass weight, the daily gain and the *longissimus* muscle area were significantly ($P < .05$) lower in weaning lambs kept on pasture (group3) compared to concentrate fed lambs (group 1). The color of lamb meat was not influenced by the feeding systems. There are important effects of production systems on total fatty acid composition of lamb muscle. The concentration of total n-3 fatty acids was significantly ($P < .05$) increased up to 83 mg/100 g muscle in lambs kept on pasture compared to 33 mg/100 g in animals fed concentrate. The elevated biosynthesis of n-3 long chain polyunsaturated fatty acids proved the 2-fold increase of C20:5n-3, C22:5n-3 and C22:6n-3 in muscle. The results of the experiment demonstrated the ability to convert absorbed C18:3n-3 to longer chain n-3 fatty acids. The ratio of n-6 and n-3 fatty acids was beneficially low as well as in concentrate fed lambs (7:1) and in grazing lambs (2:1). The significantly higher ($P < .05$) percentage of stearic acid and the sum of saturated fatty acids in muscle of grazing lambs (group 2 and 3) reflected a higher rumen activity for biohydrogenation of PUFA. Besides the contribution from landscape maintenance as well as nature preservation, a pasture feeding system can be corresponded to the consumer demand for healthier meat because of the increased n-3 fatty acid concentration.

Key Words: fatty acids, muscle, lamb

1457 Modification of essential fatty acids in phospholipids and triglycerides from beef cattle. S Lorenz^{*1}, K Nuernberg¹, and K Ender¹, ¹Research Institute for the Biology of Farm Animals.

Simmental bulls ($n = 10$) and German Holstein steers ($n = 9$) were divided in two feeding groups (intensive feeding = semi ad libitum access to a concentrate diet, extensive feeding = maintaining on a pasture). For each group the intramuscular fat content of the *longissimus* muscle and the fatty acid composition of phospholipids (PL) and triglycerides (TG) was determined. The different feeding regimes led to significant changes in the fatty acid profile of the PL and TG. Simmental bulls showed significant [$P < 0.05$] differences for each fatty acid except for C18:0 and CLA isomers *9c11t*, *7t9c*, *8t10c*. The relative amounts of these two fatty acids were constant in both feeding groups. In contrast to this a significant difference in the C18:0 level for the German Holstein steers was detected. Despite biohydrogenation in the rumen, C18:3 contained in grass was absorbed and deposited into the lipids of the muscle. This led to a significantly [$P < 0.05$] higher percentage of n-3 fatty acids in the PL in the muscle of cattle kept on pasture. The relative amount of total n-3 fatty acids in Simmentals increased from 3.2 % in the intensively fed cattle to 14.4 % in pasture fed cattle. German Holsteins showed a respective increase from 2.5 % to 12.8 %. The n-6/n-3 ratio of extensively kept Simmentals was 1.6 in contrast to 14.8 in stable-kept animals [$P < 0.05$]. However, German Holsteins showed a n-6/n-3 ratio of 1.5 (extensive) in contrast to 15.9 (intensive) [$P < 0.05$]. Differences in the fatty acid composition of TG from both feeding groups were also observed for both breeds. Grass fed Simmentals had a n-3 fatty acid level of 1.2 %; fourfold higher than the value observed in the TG of animals kept in stable. Whereas, German Holstein steers showed only a twofold increase from 0.3 % to 0.6 % [$P < 0.05$]. For both breeds

the amount of CLA isomers *9c11t*, *7t9c*, *8t10c* was constant in both feeding regimes as shown for PL. Maintaining cattle on pasture resulted in an enrichment of n-3 fatty acids in beef. The total n-3 fatty acid content in beef muscle increased from 23.2 mg to 97.8 mg/100 g muscle (Simmentals) and from 20.4 mg to 72.1 mg/100 g muscle (German Holsteins).

Key Words: fatty acids, muscle, beef

1458 Effect of L-carnitine on lamb growth and metabolites. T. W. White^{*1}, J. M. Fernandez¹, G. D. Harding¹, R. L. Walker¹, C. C. Williams¹, H.G. Bateman¹, and M. A. Froetschel², ¹Louisiana State University Agricultural Center, Baton Rouge, ²University of Georgia, Athens.

Two experiments were conducted to study the effect of L-carnitine (LC) on performance and ruminal and plasma metabolites of individually fed lambs. Weights were taken after a 16-h shrink and ruminal (84 d) and blood samples (28 and 84 d) collected 3 h post feeding after a 16-h shrink. In Exp. 1, 32 Katahdin wethers (BW=26 kg) were blocked by weight into four groups. Lambs in each group were assigned to eight treatments in a 2 x 4 arrangement of four levels (0, 50, 100, or 200 ppm) of ruminally unprotected (UP) or protected (P) LC. Lambs were slaughtered after 98 and 126 d when blocks averaged 47 kg. Ruminally PLC improved ($P < 0.06$) ADG when compared with UPLC (199 vs 184 \pm 5.1 g/d). A quadratic ($P < 0.05$) response on ADG suggests 100 ppm as optimum. Carcass composition was not affected by LC. Ruminal ammonia N levels responded ($P < 0.02$) in a linear, quadratic, and cubic manner to LC. Plasma ammonia N at 84 d was lower ($P < 0.01$) when PLC was fed than when UPLC was fed (46.1 vs 52.2 \pm 1.45 μ M). Ruminal butyrate increased ($P < 0.05$) linearly with increases in LC. In Exp. 2, 16 Suffolk wether (BW=33kg) and 16 Suffolk ewe lambs (BW=32 kg) were assigned as in Exp. 1 to corn-based or soyhull-based diets with 0 or 100 ppm PLC. Lambs were slaughtered after 84, 112, or 140 d averaging 50 kg. Lamb fed corn diets gained faster, were more efficient ($P < 0.01$) and graded higher ($P < 0.06$) than lambs fed soyhull diets. Feeding corn diets increased ruminal propionate, reduced ruminal acetate, pH, ammonia N, and plasma urea N and glucose ($P < 0.01$). Feeding PLC improved ($P < 0.09$) DMI and ADG ($P < 0.06$). Ruminal pH, ammonia N, and plasma ammonia N were reduced ($P < 0.05$) on d 84 by PLC. Individual VFA were not affected by PLC. Protected LC appears beneficial in improving ADG and reducing ruminal and plasma ammonia N levels.

Key Words: Lambs, Carnitine, Growth

1459 Effect of fat source on plasma fatty acids in sheep. H. Febel¹, F. Husveth², and T. Veresehyazy^{*3}, ¹Research Institute of Animal Breeding and Nutrition, Herceghalom, ²University of Veszprem, Keszthely, ³Szent Istvan University, Faculty of Veterinary Science, Budapest, Hungary.

This study was designed to determine whether dietary butylsoyamide and hydroxyethylsoyamide made from soybean oil escape ruminal biohydrogenation and increase unsaturated fatty acids in plasma of sheep. The effect of oleamides was compared with other fat supplements containing Ca soap or soybean oil. Five mature wethers (BW 72 kg) were fed five diets in a 5x5 latin square experiment. The control diet consisted of 50% meadow hay and 50% concentrate with no added fat. The control diet was supplemented with Ca soap (CS), hydroxyethylsoyamide (HA), butylsoyamide (BA), or soybean oil (SO). Fat was added at 3.5% of dietary DM. Each period lasted 18 days. Blood samples were taken by jugular venipuncture during the final 2 days of each period at 3h postfeeding, for determination of total cholesterol, triglyceride, total lipid and fatty acids. All fat supplements increased ($P < 0.05$) plasma triglyceride, cholesterol and total lipid. Plasma concentration of cholesterol and total lipid was highest ($P < 0.001$) with SO. Highest ($P < 0.001$) blood triglyceride was observed for the sheep fed CS supplemented diet. Plasma 16:0 decreased ($P < 0.05$) when either HA or SO was added to the diet. The inclusion of CS in the control diet increased ($P < 0.001$) 16:0. All fat supplements increased ($P < 0.05$) plasma 18:0 and decreased ($P < 0.05$) 16:1 and 18:1. Plasma 18:2n-6 was not changed ($P > 0.05$) by feeding CS and SO. However, compared to the control diet, 18:2n-6 increased 12 ($P < 0.05$) and 41% ($P < 0.001$) in plasma fatty acids when sheep were fed HA and BA, respectively. The ratio of 18:2n-6 to saturated fatty acids in plasma for the control, CS, HA, BA, and SO diets were 1.15, 0.76, 1.25, 1.5 and 1.03, respectively. The results of the current study showed that plasma concentration of unsaturated fatty acids

was enhanced more when the amide was synthesised from butylamine than when from ethanolamine. Further work is needed to determine the effect of fat supplements on ruminal fermentation and digestion.

Key Words: Oleamide, Calcium Soap, Fatty Acid

1460 The feeding of fish oil as fish meal with linoleic acid sources enhances milk CLA content. A. A. Abu-Ghazaleh*, D. J. Schingoethe, A. R. Hippen, and L. A. Whitlock, ¹South Dakota State University.

Twelve multiparous Holstein cows at 65 (33-122) DIM were used in a 4 x 4 Latin square with 4 wk periods to study the effect of feeding fish meal (FM) and /or extruded soybeans (ESB) on feed intake, milk yield and composition, and milk fatty acids with emphasis on conjugated linoleic acid (cis-9,t-11 C18:2, CLA) and trans-vaccenic acid (t-11 C18:1, TVA). Treatment diets were 1) Control; 2) 0.5 % fish oil from FM; 3) 2.5% soybean oil from ESB; and 4) 0.5% fish oil from FM and 2% soybean oil from ESB. Diets formulated to contain 18% crude protein and were composed of 50% (dry basis) concentrate mix, 25% corn silage, and 25% alfalfa hay. Intake of DM (29.4, 29.8, 29.0, and 28.8 kg/d for diet 1 to 4, respectively) was not affected ($P = 0.26$) by diet. Milk production (33.3, 34.6, 36.9, and 38.0 kg/d) was increased ($P < 0.05$) by all treatments compared with control. Milk fat percentages (3.74, 3.46, 3.19, and 3.07), and milk protein percentages (3.27, 3.26, 3.07, and 3.10) were decreased ($P < 0.05$) with ESB and FM+ESB diets. Milk fat yield (1.24, 1.18, 1.17, and 1.17 kg/d) was not affected by treatments ($P > 0.05$), but yield of milk protein (1.08, 1.12, 1.13, and 1.18 kg/d) was increased ($P < 0.05$) with supplemental FM and ESB or their blend. When FM, ESB, or their blend were fed, concentrations of CLA in milk fat increased ($P < 0.01$) by 0.4, 1.4, and 3.2, fold and TVA concentrations in milk fat increased ($P < 0.01$) by 0.4, 1.8 and 3.5 fold compared with control. The increases in CLA and TVA were much higher when a blend of FM and ESB was fed than the additive effect of FM and ESB. This indicated that fish oil caused increased production of CLA and TVA from other dietary sources of linoleic acid such as ESB.

Key Words: Conjugated linoleic acid, Fish oil, Extruded soybeans

1461 Validation of a model for the digestion of fat in dairy cows. P. J. Moate*, R. C. Boston, and W. Chalupa, University of Pennsylvania, Kennett Square, PA.

Our objective is development of a model of fat digestion within the structure of CPM-Dairy. Data from 36 diets in eight published experiments that reported intakes and flows (g/d) of long chain fatty acids (LCFA) to the duodenum and to feces were used to develop equations that described lipolysis of fat and biohydrogenation of LCFA in the rumen, ruminal production of LCFA and intestinal digestion of LCFA (J. Dairy Sci. 83(Suppl1):279-280). The model has now been validated for prediction of absorption of LCFA from the intestine using similar in vivo data from another 38 diets in eight published papers. In the table, the mean and range of the measured (X) absorbed LCFA (g/cow/d) is tabulated and the relationship between the predicted absorbed LCFA (Y) and X is given by A (Y intercept) and B (slope). Despite the fact that validation diets covered a wide range in LCFA intakes as well as diverse fat sources, there was good concordance between measured and predicted absorption of total LCFA and acceptable concordance for most individual LCFA.

LCFA	Xmean	X range	A	B	n	R ²	Bias %
Total LCFA	331	86 - 667	0*	1.02	36	0.88	2
C12:0	5	0 - 29	0.5	0.99	19	0.99	10
C14:0	7	0 - 85	1.0	0.78	26	0.99	8
C16:0	71	17 - 182	0*	0.91	36	0.96	-9
C16:1	1	0 - 4	0*	1.00	18	0.83	0
C18:0	175	36 - 375	0*	1.05	36	0.97	5
C18:1t	18	1 - 44	9.0	0.54	15	0.52	4
C18:1c	29	14 - 54	0*	0.73	15	0.90	-27
C18:2	20	2 - 87	0*	0.87	34	0.91	-13
C18:3	3	0 - 21	-0.7	1.01	31	0.91	-20
Cother	23	11 - 45	11.4	0.19	26	0.10	-32

* Intercept not significantly ($P > 0.05$) different from 0, regression forced through origin.

Key Words: Cattle, Fatty acids, Digestion model

1462 Trans fatty acids in milk of Holstein cows fed soybean oil or two forms of conjugated linoleic acid. T. C. Jenkins*, S. A. Mosley, and J. A. Bertrand, Clemson University, Clemson, SC.

The extent that milk *trans* fatty acids can be altered by fat supplements was examined by feeding lactating Holstein cows either a control diet with no added fat or three diets containing 3% added fat as either soybean oil (SBO), unprotected conjugated linoleic acid (CLA-U), or conjugated linoleic acid protected as simple amides (CLA-P). The diets were fed in a 4 x 4 Latin square design with 2-wk periods. The CLA supplement was a mixture of several conjugated dienes including the *cis*-9, *trans*-11 (22.1% of total fatty acids), *trans*-10, *cis*-12 (18.4%), and *trans*-9, *trans*-11 (6.0%) isomers. Converting the CLA supplement to amides reduced the loss of the *cis*-9, *trans*-11 isomer over 48 h from 100 to 57% in ruminal in vitro cultures. The SBO supplement had no effect on dry matter intake, milk yield, or milk protein concentration. Feeding SBO reduced milk fat from 3.2 to 2.9% with an increase ($P < 0.05$) in total *trans* monoenes from 1.89 to 5.42% of total milk fatty acids, an increase ($P < 0.05$) in the *cis*-9, *trans*-11 diene from 0.38 to 0.63% of milk fatty acids, but a decrease ($P < 0.05$) in the ratio of *trans*-11/*trans*-10 monoenes from 2.54 to 1.00. Both CLA supplements reduced ($P < 0.05$) milk fat percentage from 2.9% for SBO to 1.8%, but had no effect on milk yield or intake. Compared to SBO, the CLA-U and CLA-P supplements increased ($P < 0.05$) total *trans* monoenes from 5.42 to 10.68 and 10.71% of milk fatty acids, increased ($P < 0.05$) the concentration of all conjugated dienes, but reduced ($P < 0.05$) the ratio of *trans*-11/*trans*-10 monoenes in milk from 1.00 to 0.56 and 0.50, respectively. The CLA-P diet had higher ($P < 0.05$) *trans*-6/8 monoenes in milk, but lower ($P < 0.05$) *trans*-10, *cis*-12 and *trans*-9, *trans*-11 dienes in milk compared to CLA-U. The results show that feeding conjugated dienes, as either the free acids or amide, to lactating dairy cows increases the concentration of *trans* fatty acids (both *trans* monoenes and dienes) in milk more than feeding an equal quantity of soybean oil.

Key Words: Milk Fatty Acids, Conjugated Linoleic Acid, Milk Fat

1463 Effects of prepartum intake, postpartum induction of primary ketosis, and periparturient disorders on carnitine palmitoyltransferase I activity in dairy cows. H. M. Dann*, J. K. Drackley, and D. E. Morin, University of Illinois, Urbana.

Thirty-five multiparous Holstein cows were used to determine the role of mitochondrial carnitine palmitoyltransferase I (CPT I) in liver on periparturient adaptations of fatty acid metabolism. Cows were fed a diet (1.54 Mcal NE_L/kg, 14.1% CP) from dry-off to parturition at either ad libitum (A; n=17) or restricted (R; 80% of calculated NE_L requirements; n=18) intake. After parturition, all cows were fed a lactation diet (1.58 Mcal NE_L/kg, 16.8% CP). At 4 d in milk (DIM), cows were assigned to three groups: healthy-control (HC; n=6), healthy-ketosis induction (HK; n=9), and periparturient disorder (PD; n=17), based on a physical examination. Cows in HC and PD were fed for ad libitum intake. Cows in HK were fed at 50% of intake at d 4 postpartum from 5 DIM to signs of clinical ketosis or until 14 DIM, and then were returned to ad libitum intake. Liver was biopsied at -30, 1, 14, and 28 d relative to parturition. Mitochondria were isolated by differential centrifugation. Activity of CPT I (nmol palmitoyl-[³H]-carnitine formed·min⁻¹·mg protein⁻¹) was 5.6 and 6.9 for A and R, respectively ($P < 0.05$) at -30 DIM. Sensitivity of CPT I to its inhibitor, malonyl CoA, did not differ ($P > 0.05$) between A and R; mean IC₅₀ was 1.03 μM. Postpartum CPT I activity and malonyl CoA sensitivity were not affected ($P > 0.05$) by prepartum intake (A vs. R), postpartum group (HC vs. HK vs. PD), or time. Mean postpartum CPT I activity was 8.25 and IC₅₀ was 1.48 μM. Prepartum serum nonesterified fatty acids were correlated ($P < 0.05$) with CPT I activity at -30 (Spearman rho = 0.47) and 1 (Spearman rho = 0.48) DIM but not at 14 and 28 DIM. Prepartum intake affected prepartum CPT I activity but not malonyl CoA sensitivity. Neither induction of primary ketosis nor periparturient disorders affected CPT I activity or sensitivity, which indicates that alterations of CPT I may not be involved in the etiology of primary ketosis or other periparturient disorders.

Key Words: Carnitine Palmitoyltransferase I, Ketosis, Transition Cow

1464 Influence of feeding canola seed on lactation performance and conjugated linoleic acid concentration in milk fat of lactating Holstein cows. J.D. Handegard^{*1}, D.B. Carlson¹, M.S. Laubach¹, D.E. Schimek¹, W.L. Keller¹, J.W. Schroeder¹, C.S. Park¹, G.D. Marx², and J.H. Herbein³, ¹North Dakota State University, Fargo, ²University of Minnesota-Crookston, ³Virginia Polytechnic and State University, Blacksburg.

The objective of this study was to determine the optimum level of dietary canola seed supplementation to cause maximum increases in conjugated linoleic acid (CLA) content in milk fat. Twelve lactating Holstein cows were randomly assigned to one of three dietary treatments (0, 6, and 12% of the total diet as crushed canola seeds). Crushed canola seeds were blended into total mixed rations. Cows were housed in tie-stalls and fed individually for a period of 12 wk. Feed intake and milk weights were monitored daily. Blood and milk samples were collected every three wk. Body weight and a body condition score (BCS) were also determined at this time. Fatty acid profiles on milk were determined by gas chromatography. Analysis has shown an increase in CLA concentration in milk fat of cows on the 12% canola seed diet compared with cows on the 0 and 6% diets ($P < 0.05$). Milk production, dry matter intake, body weight, milk fat, and BCS were not significantly different between treatments. Plasma glucose and insulin were not affected by treatment. However, plasma non-esterified fatty acids of cows on the 12% canola seed diet were decreased (ca. 30%) compared to the control group ($P < 0.05$). Dietary supplementation of crushed canola seed up to 2.5 kg/d can increase CLA concentration in milk fat of lactating cows without negatively affecting lactation performance.

Key Words: Conjugated linoleic acid, Canola, Fat supplementation

1465 Conjugated linoleic acids in duodenal and milk lipids of lactating dairy cows fed different diets. L. S. Piperova^{*1}, J. Sampugna¹, B. B. Teter¹, K. F. Kalscheur¹, R. A. Erdman¹, M. P. Yurawecz², K. Ku², and K. Morehouse², ¹University of Maryland, College Park., ²U.S. Food and Drug Administration, Washington, D.C..

Duodenal and milk samples of lactating dairy cows obtained from a previous study (Kalscheur et al, 1997, J. Dairy Sci. 80:2104) were examined to determine the effect of diet on the conjugated linoleic acids (CLA) content. Four lactating Holstein cows, fitted with duodenal cannulas, were fed 4 diets in a 2x2 factorial, 4x4 Latin square design with 3 week treatment periods. The diets had two levels of forage 25% or 60% (LF or HF) with (B) or without (NB) added buffer (1.5% NaHCO₃ and 0.5% MgO). Fatty acid methyl esters were prepared using 0.7N H₂SO₄ in methanol, at room temperature, and analyzed by GLC (100m SP2560 column) and HPLC (triple Ag+- column). The total duodenal CLA were highest (1.7 g/d) in cows fed the LFNB diet, compared to both HF diets and the LFB diet. In contrast, the milk CLA yield was similar among treatments (7.1 g/d - 9.5 g/d). Regardless of the diet c-9, t-11 was the major isomer, greater than t-7,c-9 >t/c-c/t-11,13 >c-8,t-10. The difference between the milk CLA yields and duodenal flow of CLA can be accounted for by the action of the delta-9-desaturase on the t-11- and t-7-18:1 fatty acids absorbed from the duodenum. The LFNB diet produced the greatest amount of t-10, c-12 CLA in milk fat. Although it has been reported that the t-10, c-12 isomer inhibits delta-9-desaturase, the levels of c-9, t-11 and t-7, c-9 were similar in spite of the level of the t-10, c-12 CLA in milk. The results suggest that the majority of milk CLA were formed by post-absorptive synthesis from trans-18:1 fatty acids.

Item	Diets				Effects ($P <$)			
	HFNB	HFB	LFNB	LFB	SED	F	B	F x B
Duodenal CLA, g/d	1.09	1.05	1.7	0.97	0.28	0.21	0.06	0.09
Milk CLA, g/d								
Total	9.06	7.99	9.46	7.06	1.35	0.52	0.11	0.37
t-7,c-9-18:2	0.72	0.63	0.81	0.52	0.13	0.77	0.16	0.55
c-8,t-10-18:2	0.04	0.06	0.02	0.03	0.02	0.03	0.14	0.31
c-9,t-11-18:2	7.43	6.72	7.21	5.86	1.12	0.31	0.12	0.33
t-10,c-12-18:2	0.05	0.01	0.1	0.03	0.005	0.07	0.04	0.84
t/c,c/t-11, 13-18:2	0.07	0.08	0.04	0.04	0.03	0.44	0.17	0.19

Key Words: Milk, CLA, CLA isomers

1466 Metabolic fate of long chain fatty acids by ruminant hepatocytes. D.G. Mashek^{*}, S.J. Bertics, and R.R. Grummer, University of Wisconsin, Madison.

The objective was to determine the metabolism of long chain unsaturated fatty acids to oxidation or cellular lipid products. Hepatocytes were isolated from four ruminating calves and exposed for 3 hours in suspension to one of the following treatments: 1 mM palmitic acid (1C16), 2 mM palmitic acid (2C16), or 1 mM of palmitic acid plus 1 mM of oleic (C18:1), linoleic (C18:2), linolenic (C18:3), eicosapentaenoic (C20:5), or docosahexaenoic (C22:6) acid. For treatments 1C16 and 2C16, metabolism of [1-¹⁴C]palmitic acid was measured. For all other treatments, the fatty acid other than palmitic acid contained the radiolabel. Oxidation of [1-¹⁴C]fatty acids to CO₂ or incorporation into cellular triglyceride (TG), phospholipid (PL), cholesterol (C), and cholesterol ester (CE) were measured. Rates of oxidation to CO₂ were 3 to 4-fold higher for C22:6 compared to other treatment fatty acids, with the exception of C20:5, which had intermediate rates of oxidation to CO₂. Treatments 2C16 and C18:1 yielded the highest rates of incorporation into most cellular lipids, whereas the polyunsaturated fatty acids were poor substrates for incorporation into cellular lipids. The most pronounced change was a reduction of polyunsaturated fatty acid incorporation into cellular TG compared to 1C16, 2C16, and C18:1. All polyunsaturated fatty acids were incorporated into cellular TG at rates less than 25% of those observed for 2C16 and C18:1. Therefore, long chain fatty acids vary in their routes of metabolism by bovine hepatocytes. Values in the table below represent incorporation of [1-¹⁴C]fatty acids into metabolic products (pmol/ug DNA/3 h).

Pro-duct	1C16	2C16	C18:1	C18:2	C18:3	C20:5	C22:6
CO ₂	77.4 ^c	69.9 ^c	99.8 ^c	50.4 ^c	56.6 ^c	155.0 ^b	28.3 ^{2a}
TG	202.0 ^b	307.8 ^a	287.5 ^a	19.4 ^c	60.1 ^c	21.7 ^c	46.9 ^c
PL	104.9 ^{bcd}	128.6 ^{ab}	144.6 ^a	81.2 ^d	117.9 ^{abc}	78.1 ^d	90.5 ^{cd}
C	31.0 ^{bcd}	36.4 ^{bc}	84.5 ^a	42.9 ^b	40.8 ^b	24.6 ^{cd}	22.9 ^d
CE	36.2 ^b	58.2 ^a	74.4 ^a	20.2 ^b	36.5 ^b	25.4 ^b	29.5 ^b
TCL ¹	373.9 ^b	530.6 ^a	565.4 ^a	158.7 ^{cd}	226.0 ^c	145.0 ^d	188.6 ^{cd}

^{abcd}Means within a row with unlike superscripts differ ($P < 0.05$). ¹Total Cellular Lipids (TCL) = TG + PL + C + CE.

Key Words: fatty acids, hepatic metabolism, bovine

1467 Effects of feeding whole linseed on milk production and composition of dairy ewes. M. V. Pol, R. Casals^{*}, E. Albanell, and X. Such, Universitat Autònoma de Barcelona.

Forty eight multiparous Manchega dairy ewes (45 days in milk) were used in a cross-over design to study the effects of supplementing diets with whole linseed on lactational performance. Animals were blocked into two groups according to previous milk yield and assigned to one of two diets: control (C) and whole linseed (L). After a first 3-wk experimental period, ewes were switched to the alternate diet for a second 3-wk period. Measurements and samplings were done during the last week of each period. Diets were offered as total mixed rations, containing (dry matter basis) 26% dehydrated whole-plant corn, 26% dehydrated alfalfa, 8% alfalfa pellets and 40% concentrate, where barley and soybean meal were the main ingredients. Since whole linseed was included (8%) in the L diet, proportions of barley and soybean meal were reduced to obtain isonitrogenous diets (16% CP). Ether extract of the diets varied from 1.5% (C) to 3.5% (L). Milk fat content (C, 6.88; L, 7.88%) and yield (C, 80.7; L, 91.0 g/d) increased ($P < 0.01$) due to fat supplementation. In contrast, dry matter intake (DMI: C, 2.87; L, 2.85 kg MS/d), milk yield (C, 1.20; L, 1.16 kg/d), and milk protein (C, 6.06; L, 6.11%) and casein contents (C, 4.76; L, 4.77%) were not affected. However, if expressed as percentage of milk protein, casein (C, 78.56; L, 78.08% of CP) tended to decrease ($P < 0.14$). Provisional results suggest changes in the fatty acid profile of milk, with an increase of unsaturated fatty acids in the L group. Blood serum concentrations of nonesterified fatty acids (C, 0.16; L, 0.26 mmol/L), triglycerides (C, 23.6; L, 36.6 mg/dL) and cholesterol (C, 116.5; L, 153.8 mg/dl) were increased ($P < 0.001$) by the use of linseed, but glucose and β -hydroxybutyrate were not modified. In conclusion, whole linseed may be used at moderate doses in rations of dairy ewes as a natural mean to modify milk fat content without negative effects on DMI and milk protein content. Acknowledgments: CICYT-Spain (Project AGF99-0773) and Agribrands Europe-Espaa.

Key Words: Dairy Ewes, Whole Linseed, Milk

1468 Effect of supplementing Solin, a high linoleic acid oilseed, to a TMR containing fresh grass, on bovine plasma and milk conjugated linoleic acid (CLA) and fatty acid levels. A.T. Ward* and K.M. Wittenberg, *University of Manitoba, Winnipeg, Canada.*

The objective of the trial was to compare the CLA and other fatty acids levels in plasma and milk of cows fed three dietary treatments. The diets were fed as TMR's with forage to concentrate ratios of 60:40. The diets contained either conserved or fresh grass cut from the same field, supplemented with tallow, and fresh grass supplemented with solin crushed oilseed. Twelve multiparous Holstein cows were assigned to one of the three diets in a 3 x 3 Latin square design. Average feed intakes and milk yields of the cows fed the grass diets were significantly lower than feed intakes and milk yields of cows fed the hay-tallow diet. Per cent milk fat, however, was similar for the cows fed the three diets. The grass-solin diet lipid contained 54% linoleic acid as compared to 10% linoleic acid in the grass-tallow and hay-tallow diets. The proportion of the short and medium chain fatty acids were lower in the plasma and milk lipid of the cows fed the grass-solin diet compared to the grass-tallow and hay-tallow diets whereas the C18 fatty acids, except for linolenic acid, were higher in the plasma and milk lipid of the cows supplemented with the grass-solin diet. Vaccenic acid and the CLA isomer C18:2 cis-9, trans-11 were significantly higher in the plasma and milk lipid of the grass-solin fed cows compared to the cows fed the grass-tallow and hay-tallow diets. The cows fed the grass-tallow diet had a significantly higher level of C18:2 cis-9, trans-11 in plasma and milk compared to the hay-tallow diet. The milk lipid C18:2 cis-9, trans-11 CLA isomer levels in the grass-solin, grass-tallow and hay-tallow fed cows were 1.3, 1.07 and 0.93% (SEM=0.04), respectively. The cows fed the grass-tallow and hay-tallow diets had significantly higher plasma levels of the C18:2 trans-9, cis-11 CLA isomer than the cows fed the grass-solin diet, which resulted in total plasma CLA levels to be higher in the cows fed the grass-tallow and hay-tallow diets compared to the grass-solin diet. The C18:2 trans-9, cis-11 isomer, however, was not detected in the milk of the cow's fed the three diets.

Key Words: Conjugated linoleic acid, Oilseed, Fatty acids

1469 Effect of feeding frequency and dietary sunflower oil on conjugated linoleic acid (CLA) concentrations in milk from dairy cows. N.W. Lafond¹, V. Girard², and P.Y. Chouinard¹, ¹Universite Laval, QC, Canada, ²Institut de recherche et de developpement en agroenvironnement, QC, Canada.

Previous work (Kelly et al., 1998; J. Nutr. 128:881) showed that CLA content of milk can be enhanced by dietary addition of sunflower oil (SO), which is rich in C18:2. However, large variation has been observed between cows receiving the same treatment indicating that additional factors must be affecting the CLA content of milk. The objective of the present study was to evaluate if feeding behaviour can explain part of this variation. Eight multiparous Holstein cows in mid-lactation were used in a replicated 4 x 4 Latin square design with three weeks periods. Treatments were: 1) basal diet fed in 1 meal; 2) basal diet fed in 12 meals; 3) basal diet + 5% SO fed in one meal; 4) basal diet + 5% SO fed in 12 meals. Diets were fed as TMR. Treatments had no effect on milk yield but administration of SO reduced DMI (P<0.05). Rumination time, number of chews and ruminal pH were increased by the addition of SO in the diet (P<0.05). Increasing the feeding frequency tended to decrease the number of chews (P<0.07), and reduced diurnal variations of ruminal VFA, NH₃-N and pH (P<0.01). Milk fat content was increased, and milk protein content and yield were decreased when feeding frequency was increased (P<0.05). Dietary SO also reduced milk protein content and yield (P<0.05). Addition of SO enhanced the proportions (mg/100 g DM) of C16:0, C18:0, trans-C18:1, cis-C18:1, C18:2 and CLA in ruminal content (P<0.01). Increasing the feeding frequency decreased the proportion of C18:2, but had no effect on the concentration of CLA in ruminal content. Feeding SO decreased the content and yield of milk fatty acids from C6 to C17, and reduced the yield of C18:2 and C18:3 (P<0.05). Moreover, dietary SO increased milk fat content and yield of C18:0, trans-C18:1, cis-C18:1 and CLA (5.6 vs. 24.6 mg/g) (P<0.01). Feeding frequency had no effect on CLA content of milk fat. Concentrations of CLA in milk fat can be increased with the addition of SO in the diet, but feeding frequency has no effect on ruminal production and subsequent milk concentration of CLA. Supported by Dairy Farmers of Canada, NSERC, and FCAR fund.

Key Words: CLA, sunflower oil, feeding behaviour

1470 Comparison of prilled tallow and free fatty acids from tallow as fat supplements for dairy cows. S. T. Franklin*¹, D. M. Amaral-Phillips¹, J. A. Jackson¹, K. J. Touchette², and J. A. Coalson², ¹University of Kentucky, ²Merrick's, Inc.

Twenty-six Holstein cows were used in a 2 X 2 Latin square design to compare production achieved by supplementing diets with fat as prilled tallow (PT) or free fatty acids from tallow (FF). The study was conducted during July and August of 2000 which subjected the cows to heat stress. Cows were in mid to late lactation and were assigned to treatments based on lactation number (first parity = 12 and multiparous = 14), days in milk, and production. Cows were housed in a tie-stall barn to allow for individual feed intake. Diets were fed as TMR and contained 2.8% alfalfa hay, 42.1% alfalfa silage, 18.0% corn silage, 3.5% whole cottonseed, and 32.6% concentrate, DM basis. After 1 wk of acclimation to the tie-stalls, fat supplements were gradually incorporated into the diets to provide approximately 0.45 kg of supplemental fat as PT or FF per cow daily. Each period lasted 5 wk with 2 wk to acclimate to the fat supplements and 3 wk for data collection. Milk weights were recorded at each milking, a.m. and p.m. milk samples were obtained twice weekly, and feed fed and refused were recorded daily. Feed samples were obtained weekly and pooled by period for analysis. Diets were formulated to be isonitrogenous, averaging 18.5% CP, 1.64 Mcal NEL/kg, and 7.6% ether extract. Treatment did not affect (P > 0.05) DMI and averaged 23.5 kg/cow daily. During period 1, energy corrected milk from cows fed PT and FF averaged 28.5 and 30.1 kg/d, respectively, and during period 2 averaged 27.8 and 26.6 kg/d, respectively. Overall means for energy corrected milk did not differ (P > 0.05) and were 28.1 kg/d for PT and 28.4 kg/d for FF. Percent fat, fat yield, percent protein, and protein yield did not differ (P > 0.05) by treatment. Percent fat was 3.63% and yield was 1.0 kg/d for PT whereas percent fat was 3.70% and yield was 1.0 kg/d for FF. Similarly, percent protein was 3.25% and yield was 0.9 kg/d for PT whereas percent protein was 3.24% and yield was 0.9 kg/d for FF. As expected, milk production, fat yield, and protein yield were lower (P < 0.05) for first parity cows compared to multiparous cows, but there were no interactions (P > 0.05) between lactation number and production. In conclusion, milk yield and composition did not differ for cows fed fat supplements of prilled tallow or free fatty acids from tallow.

Key Words: Supplemental fat, Prilled fat, Free fatty acids from tallow

1471 Short-term feeding strategies for altering conjugated linoleic acid (CLA) content of meat. R. A. Robinson*, K. E. Griswold, G. A. Apgar, B. N. Jacobson, D. Johnson, and H. D. Woody, *Southern Illinois University, Carbondale, IL.*

Short-term (6-week) feeding strategies to alter conjugated linoleic acid (CLA) levels in meat were evaluated in a feedlot trial. The trial was designed as an incomplete 3x2 factorial with level of soy oil and level of forage as the factors. Forty Angus x Hereford steers were randomly assigned to one of four treatments (ten animals per treatment) for the last six weeks of a normal finishing period. The treatments were: 1) control standard 80:20 concentrate:forage finishing diet (C), 2) control + 4% soy oil (C4), 3) 60:40 concentrate:forage finishing diet + 4% soy oil (F4), 4) 60:40 concentrate:forage finishing diet + 8% soy oil (F8). Animals were housed in a slatted floor facility with five animals per pen (two pens per treatment), fed ad libitum, and orts were weighed daily to determine intake. Animals were weighed on a weekly basis, and average daily gain (ADG) was calculated. At termination, carcasses were yield graded, and tissue samples were collected from the longissimus dorsi for determination of fatty acid composition by GC analysis. Data were analyzed using the GLM procedures of SAS with pen as the experimental unit for ADG and animal as the experimental unit for carcass and CLA data. ADG was 3.2, 3.1, 3.4, and 3.0 for C, C4, F4, and F8, respectively, and was unaffected by treatment (P>.05). Dressing percentage, kidney, heart and pelvic fat, and quality grade were all significantly lower when oil was added to the diet (P<.05). There was a trend for backfat to be reduced with the addition of soy oil to the diet (P=.07). Increasing forage in the diet significantly increased ribeye area (P<.05), but had no effect on other carcass quality parameters. For CLA analyses, only the cis-9, trans-11 isomer was detectable in the tissue samples. The levels of CLA (mg per g of total fatty acids) found in the tissues were 2.3, 2.2, 2.7, and 3.1 for C, C4, F4, and F8, respectively. There was a significant oil effect (P<.03), and a significant oil by forage interaction (P<.03). There was a trend for a forage effect (P=.10). Short-term finishing period feeding strategies can be utilized to alter meat CLA levels.

Key Words: CLA, Beef, Short-term Feeding

1472 Conjugated linoleic acid (CLA) must be protected from rumen hydrogenation for the greatest impact on milk composition. M.M. Hawley*¹, M.A. McGuire¹, T.W. Hanson¹, and A.F. Kertz², ¹University of Idaho, Moscow, ²Agribands International, St. Louis, MO.

Conjugated linoleic acids (CLA) are fatty acids found in milk that possess beneficial properties for human health. Efforts to increase the content of CLA in milk have focused on alterations of the rumen environment to promote greater production of CLA during biohydrogenation. Certain CLA isomers also cause milk fat depression (MFD), an effect that may improve the economics of marketing milk. Calcium salts of fatty acids are commercial means to protect lipids from alterations in the rumen. The hypotheses tested included: 1) feeding of Ca salts of CLA was required to enrich milk with CLA; and 2) MFD would only occur when rumen protected CLA was fed. Eight lactating Holstein cows were randomly assigned to one of three treatment sequences in a 3 x 3 Latin square design. Periods lasted 7 d with treatments fed d 3 to 7 of each period. A 7 d rest occurred between every period to minimize any treatment carryover effect. Treatments were safflower oil, CLA as a free oil, and Ca salts of CLA. The CLA used was CLA-60, a mixture of CLA isomers. Supplements were fed to provide 100 g of total CLA per day; safflower oil was fed at 333 g/d equal to the total lipid in the Ca salts of CLA. Supplements were offered once a day before the morning feeding. No effect of treatment on DM intake (29.0 kg/d, SEM = 1.9) or milk yield (33.6 kg/d, SEM = 1.9) was detected. On d 5 of supplementation, feeding of safflower oil, CLA oil, and Ca salts of CLA increased ($P < 0.001$) concentrations of cis-9, trans-11 CLA in milk similarly compared to the first 2 d of each period (3.9 vs. 6.8 mg/g fat). The trans-10, cis-12 CLA isomer was increased ($P < 0.001$) during supplementation with CLA oil (0.8 mg/g) or Ca salts of CLA (1.9 mg/g) compared to pretreatment (0.2 mg/g). Milk fat depression was most evident for the Ca salt supplementation (30.5%) but was also detected for the CLA oil treatment (15.1%) on d 5 of supplementation. Conjugated linoleic acid can be enriched in milk without the utilization of a rumen inert form, however the extent of enrichment and MFD is less than when Ca salts are utilized.

Key Words: Milk Fat, Rumen Inert Fat, Dietary Fat

1473 Feeding Calcium Salts of Oleic Acid on Dry Matter Intake, Milk Yield, and Milk Fatty Acid Content. J.E. Delahoy*, L.D. Muller, R.F. Roberts, L.A. Kalwasinski, and F. Bargo, *The Pennsylvania State University, University Park, PA.*

The objective of this study was to evaluate the effects of feeding increasing amounts of calcium salts of oleic acid (CaOleate) on dry matter intake, milk yield, and milk fatty acid content. Ten cows (108 DIM) were paired according to milk yield, DIM, and parity, and used in a repeated measures design with four sampling periods (seven days in length). All cows were fed a basal TMR containing 17% CP, 34.4% NDF, 37% NFC, and 4% lipid. Five cows were fed increasing amounts of CaOleate mixed into the TMR at a rate of 0, 340, 680, and 1020 g/cow/d. A control group of five cows was fed the basal TMR. Milk samples were taken at the end of each period and analyzed for milk fat, milk protein, and milk fatty acids. Milk yield and DMI were determined daily. Fatty acids were measured to determine saturated fatty acid content (C4:0 to C18:0), unsaturated fatty acid content (C14:1 to 18:3), and CLA. Mean milk yield (33.9 kg), DMI (22.5 kg), milk protein (2.92%), and milk fat (3.36%) were not affected by CaOleate supplementation. Milk fat content of saturated fatty acids decreased linearly (71.2 to 59.9%; $P > 0.05$) with increased amounts of CaOleate. Milk fat content of unsaturated fatty acids (28.8 to 40.1%; $P < 0.05$) and CLA (7.1 to 15.5 mg/g of fat; $P < 0.05$) increased linearly with increased supplementation of CaOleate. Milk from cows fed 1020 g of CaOleate was processed into 2% milk and compared in a triangle test to milk from the Penn State dairy herd. Consumers detected no significant differences between the 2% milks. In summary, milk yield, DMI, milk protein, and milk fat did not differ when cows were fed increasing amounts of CaOleate. Milk fat content of saturated fatty acids were decreased and unsaturated fatty acids and CLA were increased with increasing levels of CaOleate supplementation.

Key Words: Saturated fatty acids, Oleic acid, Milk fat

1474 Effect of processing methods on the utilization of corn grain by ruminants. S.Y. Lee* and J.K. Ha, ¹Seoul National University, Suwon, Korea.

To evaluate the effect of processing methods on the utilization of corn grain by ruminants two experiments were carried out. In the in vitro

experiment, DM digestibility and fermentation characteristics were investigated with using differently processed corns (whole, 4mm-ground, finely-ground, flake, and flake-ground corn). In the in situ experiment, DM disappearance was measured and observation of corn incubated in the rumen by scanning electron microscopy was made. In vitro DM digestibility was influenced by corn processing ($P < 0.01$). Whole corn was poorly digested even after 48 h incubation. Finely-ground and flake-ground corn were more digested than the other corns. 4mm-ground corn was more digested than flake corn. Therefore, it is likely that ground corns have more effect on improving the DM digestion than flaked corns. The extent of pH reduction differed between processing methods ($P < 0.01$). pH for whole corn was reduced a little, that for flake and 4mm-ground corn were reduced slowly to 6.2-6.3. And pH for finely-ground and flake-ground corn were reduced rapidly to 6.18-6.19. The highest gas production was obtained in finely-ground and flake-ground corn, followed by 4mm-ground, flake and whole corn. NH₃-N concentration was influenced by processing method after 6 h incubation ($P < 0.01$). After 48 h incubation total VFA was the highest in finely-ground corns, followed by flake-ground, flake, 4mm-ground, and whole corn. Processed corn grains had higher acetate, propionate and butyrate concentration than whole corn. The result of in situ disappearance was similar with that of in vitro digestibility. That is, finely-ground corn grains were digested to the most extent, followed by 4mm-ground, flake and whole corn. Examination by SEM showed that the endosperm of processed corn grains, except for whole corn, was colonized by a variety of rumen bacteria, and showed extensive pitting as a result of bacterial amyolysis. It can be concluded that cattle need some kind of processing to have an improved utilization of corns from the result of in vitro, in situ experiment.

Key Words: Corn, Processing, Ruminants

1475 Effect of two protein sources on ADG, reproductive performance, ruminal fermentation and digestion kinetics in beef cattle. O. Ruiz-Barrera¹, J. Mejia-Haro², J.A. Jimenez-Castro¹, J.A. Ramirez-Godinez¹, I. Mejia-Haro*³, and A. Flores-Marielarena¹, ¹Universidad Autonoma de Chihuahua, Mexico, ²Universidad de Guanajuato, Mexico, ³CIGA-ITA de Aguascalientes, Mexico.

To evaluate the chemical composition of a rye grass-oat pasture and the effect of supplementation of ruminal undegradable protein on performance, 100 bulls and 62 heifers were fed for 112d. Cattle were randomly assigned to one of two treatments: 1) rye grass-oat pasture, oat hay and a ruminal degradable protein supplement (PDR) based on poultry manure and urea; and 2) rye grass-oat pasture, oat hay and a ruminal undegradable protein supplement (PNDR) based on blood meal and cottonseed meal. One month before the end of the experiment SyncroMate-B was applied to all cycling heifers. Blood samples were taken from the jugular vein at implant insertion, implant removal (before feeding) and 8 h after feeding (after implant removal). A cervical mucus sample was taken at estrus to determine pH, and 15 h after the beginning of the estrus, heifers were inseminated. One month before the end of the experiment, the semen quality was evaluated and blood samples were taken from the jugular vein to determine blood pH and urea. Dry matter, OM, CP, ADF, NDF, ME and in vitro digestibility was determined in feed and fecal samples. Data were analyzed by ANOVA using the GLM of SAS (1993). Average daily gain of bulls and heifers was not affected ($P > .05$) by treatments. Values of blood urea were not different ($P > .05$) between treatments. The pH in cervical mucus and blood serum samples taken at implant insertion, implant removal (before feeding) and 8 h after feeding (after implant removal) did not show differences ($P > .05$) between PDR and PNDR. The pregnancy rate was 46 and 77 % for PDR and PNDR, respectively ($P < .05$). Blood urea values were similar ($P > .05$) between bulls of PDR and PNDR. No differences were observed in sperm concentration, percentage of live and dead cells, masal motility, progressive motility, and abnormalities. With maturity of the pasture, a tendency to increase the content of DM, ADF and NDF and decrease CP, DM and OM digestibility, and ME was observed. No differences ($P > .05$) were observed in ADG and values of blood urea, blood pH and pH of cervical mucus samples. The decrease in fertility in heifers fed PDR could be due to the high values of blood urea found 8 h after feeding. Kind of protein did not affect ADG, blood urea and semen quality.

Key Words: Protein, Undegradable, Fertility

1476 Finishing system (feedlot or pasture) and copper supplementation affect conjugated linoleic acid in beef muscle. T.E. Engle*¹ and J.W. Spears², ¹Colorado State University, Fort Collins, ²North Carolina State University, Raleigh.

Sixty Angus steers (413 kg initial wt) were used to determine the effect of copper (Cu), corn type, and finishing system (confinement vs pasture) on performance and fatty acid composition of beef longissimus muscle. Steers in confinement were fed high concentrate diets, containing either control or high oil corn, individually, using Calan gate feeders. Steers grazing pasture (tall fescue) were maintained in 4 replicates with each replicate consisting of 5 steers. Salt was used to limit concentrate intake in pasture steers to approximately 67% of that observed in confinement steers. One half of the steers in each treatment received a CuO needle bolus at the initiation of the study while the remaining steers received no supplemental Cu. Equal number of steers per treatment were slaughtered after 91, 112 or 133 days on feed. Gain was lower ($P < 0.01$; 1.22 vs 1.57 kg/d) for pasture steers compared with those fed in confinement. Copper increased ($P < 0.05$) ADG in steers fed control corn (1.75 vs 1.50 kg/d) and pasture (1.29 vs 1.14 kg/d) but not in steers fed high oil corn diets (1.51 vs 1.54 kg/d). Gain, DM intake and gain:feed did not differ between steers fed control or high oil corn. Longissimus muscle C18:1 ($P < 0.06$), C18:3 ($P < 0.07$) and C18-conjugated dienes ($P < 0.001$) were higher in pasture-finished steers relative to the control and high oil corn finished steers. The C18:1 trans isomer ($P < 0.06$), C18:0 ($P < 0.06$), and total saturated fatty acids ($P < 0.06$) were lower in longissimus muscle of steers that received a Cu bolus. C18-conjugated dienes were higher in longissimus muscle of steers receiving a Cu bolus finished on pasture ($P < 0.06$) and in steers receiving a Cu bolus finished on the control diet ($P < 0.07$) relative to the non-Cu bolus supplemented steers. These results indicate that finishing cattle on pasture with limited grain increases C18-conjugated dienes in longissimus muscle and that Cu supplementation may alter lipid metabolism.

Key Words: Copper, Fatty Acid, Steer

1477 Interaction of steam reduction and tempering on the feeding value of steam-flaked corn for feedlot cattle. R. A. Ware*, S. A. Rodriguez, and R. A. Zinn, *University of California, Davis.*

Two trials were conducted to evaluate the interaction of steam reduction (419 vs 335 kPa pressure along a 6.35 cm diam steam line, measured 90 cm proximal to steam chest splitter valves) and tempering (60 min exposure to 40 g/kg water plus .275 mg/kg of SarTemp[®]; SarTec, Anoka, MN) on the feeding value of steam-flaked corn (SFC) for feedlot cattle. The SFC was prepared by steaming for 30 min before flaking to a density of .31 kg/L. The SFC was then allowed to air-dry before inclusion into experimental diets. Experimental diets contained 76% SFC (DM basis). Ninety-six crossbred steer calves (347 kg) were used in a 56-d trial to evaluate treatment effects on performance and dietary NE value. There were no treatment effects ($P > .20$) on ADG (1.24 kg/d), DM conversion (5.60 kg DM/kg ADG), and dietary NE_m and NE_g (2.24 and 1.55 Mcal/kg, respectively). Expected (NRC, 1984) dietary NE values for maintenance and gain were 2.23 and 1.55 Mcal/kg. Close agreement between observed and expected dietary NE indicates that across treatments the NE values for SFC were consistent with tabular values (2.38 and 1.68 Mcal/kg, respectively). Four Holstein steers (223 kg) with ruminal and duodenal cannulas were used in a 4x4 Latin square design to evaluate treatment effects on digestive function. Intake of DM was limited to 2% of BW. The percentage of corn starch that was reactive to amylglucosidase (a measure of starch solubility) was similar across SFC treatments, averaging 22%. Ruminal digestion of OM averaged 65% and was not affected ($P > .20$) by treatments. Tempering increased (5%, $P < .05$) ruminal starch digestion. However, ruminal starch digestion was not influenced by steam reduction (81 vs 80%, $P > .20$). Total tract digestion of OM and starch also were not affected ($P > .20$) by treatments, averaging 68 and 98%, respectively. We conclude that if the lower quarter of the steam chest is maintained at temperatures greater than 100° C, reducing steam application by as much as 20% will not detrimentally affect the feeding value of SFC. Due to the absence of a main effect of steam reduction on the feeding value, the interaction of tempering at lower level of steam application was not fully addressed in this study.

Key Words: Steam, Corn, Cattle

1478 Alternate equation forms for heat production estimation in ruminant growth and composition models. J.W. Oltjen* and R.D. Sainz, *University of California, Davis.*

As an alternative to the static representation of heat production (HP) as the sum of that used for maintenance and that used for gain in feeding systems or dynamic growth models, we have investigated a multiple regression on visceral (V, kg) and non-visceral (M, kg) protein and accretion of V and M. Either HP representation can be used in our recently developed dynamic model of the two protein and fat pools. That is, the fit of the model to data, using either traditional concepts of net energy and maintenance, or more general functions for heat production, can be compared to choose the best functional description. In the model, net energy for gain, the difference between metabolizable energy intake and heat production, drives the growth of V and M. Our objective was to estimate parameters and fit of heat production equations for both 72 growing lambs (Ferrell et al., 1986, *Brit. J. Nutr.* 56:595) and 144 steers (Sainz et al., 1995, *J. Anim. Sci.* 73:2971) undergoing various trajectories of compensatory and normal growth. The best equation for rams ($r^2=.987$) was HP, mCal/d = .243 ($\pm .080$) M + 2.52 ($\pm .81$) V + 14.6 (± 3.3) dM/dt + 67.6 (± 21.9) dV/dt where figures in parenthesis are SE of regression coefficients. For steers the experimental design provided fewer growth trajectories and no weight loss periods; the equation HP, mCal/d = .0657 ($\pm .0696$) M + 1.63 ($\pm .60$) V + 16.7 (± 3.4) (dM/dt+dV/dt) fit steers ($r^2=.965$). In the regression, heat production per V is generally much greater than that for M. In the growth model, V responds faster than M to changing energy intake by the animal; this makes maintenance requirement a dynamic variable depending on nutritional history as well as current energy intake. Thus, the static form of maintenance function used in traditional feeding systems is likely to be inappropriate, especially in dynamic situations.

Key Words: Energy Metabolism, Body Composition, Growth Models

1479 Effects of moisture, roller setting and saponin-based surfactant on growth performance of feedlot steers. Y. Wang*¹, T. A. McAllister¹, and D. Greer², ¹Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, ²AgriChem, Inc., Anoka, MN.

The effects of roller setting, moisture content, and a saponin-based surfactant (GrainPrep[®], AgriChem, Inc.) on performance of feedlot cattle were studied using 138 individually fed British cross steer calves ($n = 23$) and six barley silage/rolled barley grain diets for backgrounding (Bk) and finishing (Fn). Barley grain was rolled dry (D), tempered to 20% moisture (M), or tempered (20% moisture) and treated with 60 ppm of surfactant (MS); and with rollers set to produce optimal particle size from dry barley (+D) or set to produce optimal particle size from MS barley (+MS). The resulting diets were fed daily as total mixed rations, with a 4-wk transition from Bk to Fn. Dry matter intake (DMI) was higher ($P < 0.01$) during Bk, Fn and overall when barley was rolled at +D, than at +MS. With barley rolled at +D, average daily gain (ADG) was higher ($P < 0.01$) during Bk, but was unaffected ($P > 0.05$) during Fn, and tended to be higher ($P = 0.084$) overall. Feed efficiency (FE) tended ($P = 0.106$) to be improved during Bk, but was poorer during Fn ($P < 0.001$) and overall ($P < 0.011$), when rollers were set at +D than at +MS. Tempering the barley did not affect DMI, ADG or FE during Bk ($P > 0.05$), but greatly increased DMI and ADG ($P < 0.001$) and improved FE ($P < 0.001$) during Fn and overall. Enhancement of growth rate by tempering was greater ($P < 0.05$) if barley had been rolled at +D than at +MS. Tempering with GrainPrep[®] (MS diets) increased ($P < 0.05$) ADG, relative to M diets, when rollers were set at +MS. Roller setting did not affect ($P > 0.05$) carcass characteristics, but M and MS diets increased ($P < 0.05$) warm carcass weight and saleable meat yield and tended to increase ribeye area ($P = 0.072$), relative to D diets. Tempering barley grain prior to rolling improved growth performance relative to rolling dry grain. The positive effects of GrainPrep[®] on performance were enhanced when barley was rolled to 72% of original bulk density (+MS) as compared to 78% (+D).

Key Words: Saponin, Barley grain, Feedlot cattle

1480 Effects of high oil corn and shade on respiration rates and acid-base balance of Angus and Bonsmara x Beefmaster feedlot steers. T. C. Bramble¹, C. R. Richardson*¹, J. D. Thiebaud², F. N. Owens³, and G. R. Chapman⁴, ¹Texas Tech University, Lubbock, ²Texas Tech Howard Hughes Medical Institute, Lubbock, ³Du Pont Specialty Grains, Des Moines, IA, ⁴Amarillo, TX.

This experiment was designed to determine if high oil corn (HO) or supplemental shade affects respiratory rates (RR) and acid-base balance (ABB) of feedlot steers in partially slotted floor outdoor feedlot pens. Steers, Angus (A) (n=59; BW = 322 ± 2.2 kg) and Bonsmara x Beefmaster (B) (n = 56; BW = 294 ± 2.1 kg) breeding were fed for 150 d (July 17 to December 13, 2000). Breed was nested within each of the 24 pens and steers were blocked into pens by weight. Treatments were: NST (no shade, typical corn), NSHO (no shade, high oil corn), ST (shade, typical corn), and SHO (shade, high oil corn). The HO replaced T on a weight basis, and diets were formulated to meet or exceed NRC (1996) requirements. Shade structures, black, 80% light-occluding polypropylene cloth fixed 3 m above pens, covered 67% of the pen area (9.8 m² of shade/steer). On 25 d throughout the study, RR were measured for one A and one B steer in each pen (n = 48) at 0730 and 1600. Blood gas measurements [(pH, pCO₂, pO₂, HCO₂, TCO₂, and base excess (BE)] to assess the ABB of steers were based on jugular vein blood samples (n = 24, 1 steer/pen, 12 A, 12 B) taken on d 0, 28, 56, 85, 115, and 150. The RR was 22% faster (P < .01) for NS than S steers and 80% faster (P < .01) for A than for B cattle in the afternoon (1600). Shades decreased RR of A cattle by 26% (P < .02) and of B cattle by 15% (P < .01). Cattle fed HO had greater (P = .02) RR than cattle fed T. On d 28 and 85, BE values were greater (P = .07) for shaded steers. Bicarbonate values were higher for S cattle on d 28 (P = .07), and blood was more (P < .10) basic in pH on day 85 for cattle fed HO. Shades may increase the alkalinity of venous blood even though they reduce RR. This suggests that respiration rate alone is inadequate as a predictor of blood acid-base balance of growing steers given ad libitum access to feed.

Key Words: High oil corn, Acid-base balance, Respiration rate

1481 An evaluation of breed and diet on plasma leptin concentration in beef steers. K.A. Johnson*¹, P.S. Mir², P.S. Kuber¹, Z. Mir², D.H. Keiser³, C.T. Gaskins¹, J.J. Michal¹, J.R. Busboom¹, and J.J. Reeves¹, ¹Washington State University, Pullman, WA, ²Agri-Food Canada, Lethbridge, Alberta, ³University of Missouri, Columbia, MO.

To examine the impact of breed and diet on plasma leptin concentration 36 steers of Limousin (L n=12), Wagyu (W n=12) and Limousin x Wagyu F1 cross genetics (LW n=12) were randomly assigned to one of two dietary treatments (0% and 6% sunflower oil). Blood samples were collected at the initiation and end of the feeding trial and plasma leptin determined by radioimmunoassay. At the same time, measurements of body weight, ultrasound measurement of ribeye area (REA) and fat thickness (FT) were made. Predictions of intramuscular lipid were made from the ultrasound images. After the background phase (112d), steers were fasted and plasma collected for leptin analysis. At harvest (d 212) carcass weight, FT, REA, yield grade (YG) and marbling measurements were collected. There was no effect of diet on leptin at any time. Initial leptin was not different among breed groups (L 2.04 ± 0.29 ng/ml; LW 3.12 ± 0.61 ng/ml; W 2.97 ± 0.62 ng/ml). Leptin at fasting did not differ (P<.13) by breed (L 1.35 ± 0.31 ng/ml; LW 1.90 ± 0.32 ng/ml; W 2.25 ± 0.40 ng/ml). Wagyu had greater (P<.02) final leptin (13.2 ± 1.43 ng/ml) than L (9.53 ± 0.97 ng/ml) or LW (9.76 ± 0.93 ng/ml). Carcass weight, REA, and YG differed by breed at harvest (P<.01). Marbling scores and quality grade were different (P<.0001) among breed types with W (866.7; prime -) being highest, followed by LW (583.3; choice -) and L (470.8; select +). Correlation analysis indicated no significant relationship between plasma leptin collected at any time and carcass traits. While plasma leptin was not useful as a predictive tool in determining carcass fatness, the final leptin concentration did reflect final quality grade.

Key Words: Leptin, Beef Cattle, Wagyu

1482 Corn processing method in finishing diets containing wet corn gluten feed. T.L. Scott*, C.T. Milton, T.J. Klopfenstein, and R.A. Stock, University of Nebraska-Lincoln.

Four finishing trials were conducted to determine the effects of corn processing method on performance of steers fed diets containing wet corn gluten feed (WCGF). In Trial 1, 300 calves were fed five factorially arranged treatments: 1-4) dry-rolled (DRC) or steam-flaked corn (SFC) with or without 32% WCGF; and 5) SFC+DRC without 32% WCGF. Intake was similar when feeding corn grain and increased (P<0.10) by different magnitudes (1.2 and 0.7 kg/d) when feeding DRC and SFC with WCGF. Feeding WCGF improved (P<0.10) ADG and reduced (P<0.10) efficiency compared to feeding corn grain alone. Intake and performance were similar when WCGF or DRC replaced SFC. Daily gain was similar and efficiency improved (P<0.10) by feeding SFC versus DRC. In Trial 2, the DRC/WCGF and SFC/WCGF from Trial 1 were used as control treatments and another 180 calves were fed three treatments: 1) high-moisture (HMC), 2) finely-ground, and 3) whole corn all with 32% WCGF. When feeding WCGF, whole corn increased (P<0.10) intake compared to SFC, HMC, or finely-ground corn with DRC being intermediate. Processing method did not affect ADG. Efficiency was reduced (P<0.10) by feeding whole corn compared with other treatments. Feeding SFC, HMC, or finely-ground corn improved (P<0.10) efficiency compared to DRC. Efficiency was improved (P<.10) by feeding SFC compared to finely-ground corn. In Trial 3, 192 yearlings were fed four factorially arranged treatments: 1-4) DRC or SFC with or without 22% WCGF. Intake was similar in steers fed corn grain and increased (P<0.10) by different magnitudes (1.1 and 0.5 kg/d) when feeding DRC and SFC with WCGF. Feeding WCGF improved (P<0.10) ADG while feed efficiency was similar. Both ADG and efficiency were improved (P<0.10) by feeding SFC compared to DRC. In Trial 4, the DRC/WCGF and SFC/WCGF from Trial 3 were used as control treatments and an additional 96 yearlings were fed two treatments: 1) HMC and 2) finely-rolled corn both with 22% WCGF. When feeding WCGF, intake was similar; however, SFC improved (P<0.10) both ADG and efficiency compared with other treatments. Performance was similar among steers fed DRC or HMC. Feeding HMC improved (P<0.10) efficiency compared to finely-rolled corn. In diets containing WCGF, feed efficiency tended to be improved by more intensive processing methods.

Key Words: Beef Cattle, Grain Processing, Byproduct Feeds

1483 Sub-clinical ruminal acidosis in feedlot cattle fed a barley-based diet. G. R. Ghorbani*^{1,2}, K. A. Beauchemin¹, and D. P. Morgavi¹, ¹Agriculture and Agri-Food Canada, Lethbridge, AB, T1J 4B1, Canada, ²Isfahan University of Technology, Isfahan, Iran.

Sub-clinical acidosis can reduce feed efficiency and growth rate in cattle, thereby causing significant economic losses to the feedlot cattle industry. A study was conducted to determine the prevalence of subclinical ruminal acidosis in feedlot cattle fed for maximum growth rate. Measurements of rumen pH, blood pH and DMI were made using six ruminally cannulated steers over a 9-week period. On three occasions during the experiment, ruminal pH was measured every 15 min for 6 d using indwelling electrodes. DMI was measured for each animal daily and blood pH was measured before feeding three times during the experiment. Steers were provided ad libitum access to a diet containing steam-rolled barley, barley silage, and a protein-mineral supplement; 87, 9, and 4% (DM basis), respectively. Mean values (SD) were: DMI, 9.29 (1.87) kg/d; blood pH, 7.37 (0.028); ruminal pH, 5.70 (0.41); maximum pH, 6.43 (0.25); minimum pH, 5.17 (0.43); hours pH < 5.8, 12.43 (8.09); area below 5.8 and the curve, 6.59 (5.8) pH x h/d; hours pH < 6.2, 17.8 (5.91), and area below 6.2 and the curve, 12.43 (6.2) pH x h/d. There was a significant effect (P < 0.05) of day on all rumen pH variables, except for maximum pH. Furthermore, there was no correlation (P > 0.05) between pH variables (mean pH, hours pH < 5.8, or < 6.2) and blood pH or DMI. Using the DMI and forage eNDF (measured as the proportion of the DM retained on the Penn State Particle Separator) obtained in this experiment, the NRC (1996) model predicted a mean rumen pH of 5.81, 0.11 units higher than observed. The eNDF needed to be reduced in the model from 34% to 18% to accurately predict the observed pH. In conclusion, the incidence of ruminal subclinical acidosis in feedlot cattle fed barley-based diets is prevalent, and higher than would be predicted based on the NRC (1996) model.

Key Words: Sub-clinical acidosis, Feedlot diet, Rumen pH

1484 Adaptation of the Cornell Net Carbohydrate and Protein System to sheep: validation of feed digestibility. A. Cannas*¹, D.G. Fox², A.N. Pell², and P.J. Van Soest², ¹University of Sassari, Sassari, Italy, ²Cornell University, Ithaca, NY.

A new feeding system for sheep, based on the structure of the Cornell Net Carbohydrate and Protein System (CNCPS) for cattle, was developed. The goal was to overcome some of the limitations of currently available feeding systems for sheep, with special regard to the estimation of feed values at different levels of intake. This system, called sheep-CNCPS, integrated current knowledge on sheep requirements into the structure of the CNCPS for cattle. The equations used to estimate energy and protein requirements were obtained by incorporating those published in the literature. Except for the predictions of feed and liquid passage rates, which were based on new equations developed for this system, the submodels used to estimate the supply of nutrients were those of the CNCPS for cattle. The sheep-CNCPS predictions of feed digestibility were validated by using 14 published *in vivo* total tract digestibility experiments, in which 56 different diets were tested. The sheep-CNCPS slightly underestimated DM digestibility (%) (mean bias -2.07, model bias -3.3, RMSPE 4.17; n=41) and OM digestibility (%) (mean bias -1.17, model bias -1.6, RMSPE 3.97; n=36). NDF digestibility (%) was predicted with lower accuracy than OM and DM (mean bias -2.17, model bias -5.1, RMSPE 9.90; n=56). When two distinct outliers were discarded, the prediction of NDF digestibility was substantially improved (mean bias -1.01, model bias -2.9, RMSPE 7.58). Dietary CP digestibility (%) was grossly underestimated (mean bias -5.58, RMSPE 15.31; n=42), with three feeds having negative digestibility, probably because of the large overestimation of fecal metabolic nitrogen. When they were discarded, the prediction was markedly improved (mean bias -2.53, model bias -2.0, RMSPE 9.45). Overall, the sheep-CNCPS predicted feed DM, OM, and NDF digestibility quite accurately, but it was less reliable in the case of CP digestibility.

Key Words: Sheep, Feeding system, Digestibility prediction

1485 Effect of moisture heat damage on ruminal degradation of cottonseed dry matter and crude protein using nylon bag technique in sheep. A. Estrada* and R. Barajas, Universidad Autonoma de Sinaloa (Mexico).

To determine the effect of moisture heat damage on ruminal degradation of cottonseed dry matter and crude protein a study using the nylon bag technique was conducted. Four sheep (Pelibuey; BW = 34 kg) were fitted with T canula in rumen. The animals were fed a diet containing 12% corn straw, 10% cottonseed, 10% moisture heat damaged cottonseed, 57% sorghum grain, 8% sugar cane molasses, 0.9% urea, and 2.1 mineral premix (15% CP and 3.55 Mcal DE/kg). Moisture heat damaged cottonseed was processed by adding 30% water and bulk-stacking for 7 d. Pairs of nylon bags (12 x 18 cm) containing five grams of ground undamaged cottonseed (UCS) or moisture heat damaged cottonseed (DCS) were placed in the rumen, and incubated for 3, 6, 9, 12, 24, 48, and 72 h. After removal from rumen, residual DM and CP content were determined. Water addition and stack processing increased the cottonseed temperature from 34 to 65 °C in 5 d (7.7 °C/day; R² = 0.99; P<0.001). After that time temperature was constant. DM solubility of DCS was 33% lower (P<0.01) than UCS-DM. At 12 h of incubation DCS-DM was 18% lower (P<0.01) than UCS-DM. The degradation rate (c) of DCS-DM was lowered by 33% (0.09 vs. 0.06%/h). The crude protein solubility was diminished (P<0.03) by moisture heat damage (40 vs. 31%). Rumen degradation rate of CP from DCS was 32% lower than UCS-CP (0.028 vs. 0.019%/h). The true ruminally degraded CP of UCS was calculated to be 79.4% and the corresponding value of DCS was 70.6%. Consequently the rumen undegradable crude protein of cottonseed was increased in 42% (20.6 vs. 29.5%) due to moisture heat damage. It is concluded that the water addition to cottonseed and its further bulk-stacking for 5d is able to increase its temperature enough to reduce the solubility and degradability of cottonseed crude protein in rumen, and to increase significantly its rumen undegradable crude protein content.

Key Words: Cottonseed, Heat damage, Crude protein

1486 Effect of close-up protein supplementation on milk, fat and protein yields of late gestation primiparous Holstein dairy cows. P. H. Robinson*¹, J. M. Moorby², and M. Arana³, ¹University of California, Davis, CA, ²IGER, Aberystwyth, UK, ³UCCE, Stockton, CA.

To define the impact of supplementation of CP in the late (close-up) gestation period of primiparous dairy cows, on yield of milk and its components, a diet of corn silage (17% of DM), alfalfa hay cubes (24%), oat hay (25%), barley (16%) and corn grains (16%) was limit fed at 12.1 kg DM/d. A supplement of canola meal (60%), dried distillers grains (20%), blood meal (10%), feather meal (5%), and corn gluten meal (5%) was not fed (11.7% CP; DM), or fed at 1.1 kg/d (14.4% CP) or at 2.3 kg/d (16.6% CP). Milk, protein and fat yields of 154 primiparous Holstein heifers, that were close-up for 1 to 18 d and offered one of the diets (n = 51, 53 and 50 for diets 11.7, 14.4 and 16.6% CP), were measured monthly for the first 150 d of lactation. Following calving, all cows received the same diet containing 17.7% CP and 32% NDF (DM). For statistical analysis of treatment means, cows were allocated to one of four groups based upon time close-up (1-4, 5-8, 9-12 and 13-18 d). Data were analysed by multiple regression with diet CP, its square, days close-up, its square and cube, and their interactions, with progressive removal of non-significant terms. Milk yield was highest for cows offered the 14.4% and 16.6% CP diets for more than 8 d. Protein yields were similar for all diets, but tended to be highest for the 14.4% CP diet fed for 9-12 d. Fat yields were not significantly described by the parameters of the regression model. The amount of supplement fed close-up, and the length of time that animals were close-up and received it, both influenced milk and milk protein yield. Overall, the optimal combination was 14.4% CP for 9-12 d.

Diet CP %	Days close-up			
	1-4	5-8	9-12	13-18
Milk, kg/d				
11.7	32.6	32.1	33.0	32.3
14.4	29.0	33.8	34.4	33.4
16.6	33.9	31.3	32.0	34.5
Protein, kg/d				
11.7	1.06	1.04	1.07	1.04
14.4	0.94	1.06	1.08	1.05
16.6	1.14	1.02	1.01	1.07
Fat, kg/d				
11.7	1.12	1.07	1.22	1.11
14.4	1.04	1.18	1.18	1.10
16.6	1.21	1.14	1.11	1.21

Regressions: Milk R²=86.2; s.e. obs.=0.571; P<0.05. Protein R²=86.5; s.e. obs.=0.027; P<0.05. Fat R²=74.1; s.e. obs.=0.029; P=0.20.

Key Words: Close-up, Transition, Protein

1487 Effect of close-up dry period protein supplementation on milk, fat and protein yields of multiparous Holstein dairy cows. J. M. Moorby¹, P. H. Robinson*², and M. Arana³, ¹IGER, Aberystwyth, UK, ²University of California, Davis, CA, ³UCCE, Stockton, CA.

To define the impact of supplementation of CP in the late (close-up) dry period of multiparous dairy cows, on yield of milk and its components, a diet of corn silage (17% of DM), alfalfa hay cubes (24%), oat hay (25%), barley (16%) and corn grains (16%) was limit fed at 12.1 kg DM/d. A supplement of canola meal (60%), dried distillers grains (20%), blood meal (10%), feather meal (5%), and corn gluten meal (5%) was not fed (11.7% CP; DM), or fed at 1.1 kg/d (14.4% CP) or at 2.3 kg/d (16.6% CP). Milk, protein and fat yields of 177 multiparous Holstein cows, that were close-up for 1 to 18 d and offered one of the diets (n = 46, 68 and 63 for diets 11.7, 14.4 and 16.6% CP), were measured monthly for the first 150 d of lactation. Following calving, all cows received the same diet containing 17.7% CP and 32% NDF (DM). For statistical analysis of treatment means, cows were allocated to one of four groups based upon time close-up (1-4, 5-8, 9-12 and 13-18 d). Data were analysed by multiple regression with diet CP, its square, days close-up, its square and cube, and their interactions, with progressive removal of non-significant terms. Milk yield was highest for cows offered the 14.4% CP diet for 9-12 d, but declined on all diets fed longer. Protein yields were highest for the 16.6% CP diet fed for up to 12 d, lowest on the 11.7% CP diet fed for 1-4 d, and declined with all diets fed for 13-18 d. Fat yields were highest for the 16.6% CP diet for 1-4 d, but declined on all diets fed

for 13-18 d. The amount of supplement fed close-up, and the length of time that animals were close-up and received it, both influenced milk and milk component production. Overall, the optimal combination was 14.4% CP for 9-12 d.

Diet CP %	Days close-up			
	1-4	5-8	9-12	13-18
Milk, kg/d				
11.7	42.1	40.5	42.1	40.2
14.4	41.2	41.6	42.9	40.0
16.6	42.0	41.9	41.8	39.6
Protein, kg/d				
11.7	1.31	1.28	1.37	1.29
14.4	1.36	1.33	1.36	1.28
16.6	1.36	1.34	1.33	1.28
Fat, kg/d				
11.7	1.43	1.38	1.36	1.28
14.4	1.35	1.32	1.37	1.39
16.6	1.42	1.44	1.35	1.27

Regressions: Milk $R^2=99.2$; s.e. obs.=0.088; $P<0.01$. Protein $R^2=99.9$; s.e. obs.=0.001; $P<0.01$. Fat $R^2=89.9$; s.e. obs.=0.017; $P=0.03$.

Key Words: Close-up, Transition, Protein

1488 Simulation of the effect of N excretion on environmental pollution arising from dairy cows using a dynamic model. E. Kebreab*¹, J. France¹, J.A.N. Mills¹, R. Allison², and J. Dijkstra³, ¹The University of Reading, ²ADAS Bridgets, ³Wageningen Institute of Animal Sciences.

Agriculture is one of the major sources of nitrogen (N) pollution. To increase animal products, cattle and especially dairy cows, are offered increasingly higher amounts of N but the efficiency with which N is converted to animal product is low leading to excess N to be excreted in feces and urine. From an environmental perspective, losses of N as urine is less desirable due to its greater tendency to leaching and volatilization as ammonia, the major source of which is urea from urine. A dynamic model was developed to predict the amount and source of N in excreta and to assess the impact of manipulating diet to reduce N pollution by improving N utilization. Five N balance experiments conducted at the Centre for Dairy Research (The University of Reading) were used to parameterize the model and an independent data from experiments conducted at ADAS Bridgets were used to evaluate the model. The model showed that energy and protein content of the diet affect N utilization. The model predicted that cows fed a low degradable starch supplement (corn) gave up to 65% lower N excretion and a higher protein concentration in milk. In addition, feeding cows corn-based diets reduced urinary N excretion by almost 30% compared with barley-based concentrates. As a result, feeding corn-based diets has a potential to reduce ammonia emissions by up to 26%. It was also shown that it is possible to improve N utilization in dairy cows by decreasing protein intake on balanced diets. Reducing the protein content from 190 to 160 g/kg DM substantially reduced N in urine without compromising lactational performance which could potentially reduce ammonia emissions from dairy cows by 21% and nitrous oxide by 15%. Diets with low degradable protein sources also reduced N output in urine with little change in milk production. Inclusion of a lower degradable protein in the diet will potentially contribute to a reduction of ammonia emissions by 20% and nitrous oxide by 8%.

Key Words: N utilization, Environmental pollution, Dairy cows

1489 Should residual plots use Y or Yhat? N.R. St-Pierre*, The Ohio State University.

Evaluation and validation of models (empirical or mechanical) require analyses of error structure in the form of residual plots. The appearance of numerous residual plots in recent literature where the residuals are plotted against observed (Y) values to assess a model's bias raises the question whether residuals should be plotted against Y or against predicted values (Yhat). This requires knowing the expected relationship under the assumption of an unbiased model. The objectives of this research were to derive the expected relationship between residuals and Y and to determine whether Y or Yhat should be used for the assessment of bias. Assume a true model of the form $Y = X\beta + \epsilon$. This model is estimated by $Y = Xb + e$, and $Yhat = Xb$. Least-squares estimates of

b are unbiased and have minimum variance among all linear estimators of β . The correlation between the residual vector e and the vector of observations Y is calculated as follows. The numerator of the correlation coefficient is shown to be equal to $e'e$, the residual sum of squares. The denominator of this correlation is equal to the square root of $e'e$ multiplied by the total sums of squares. Algebraic simplifications show that the correlation between e and Y is equal to the square root of $(1-R^2)$. That is, under the assumption of an unbiased model, the residuals are correlated with the observed values and the slope of e regressed on Y is equal to $(1-R^2)$. Thus, a graph of e versus Y will show a positive slope between e and Y unless the model is a perfect predictor (i.e., the R^2 is equal to 1.0). Significant slopes linking e to Y have been erroneously interpreted as evidence of biased models. The correlation between e and Yhat is easily shown to be equal to zero. Thus, the slope of e regressed on Yhat is expected to be zero under the assumption of an unbiased model. These results clearly prove that plots of residuals on observed values are incorrect for assessing a model's bias. Residual plots should be done on Yhat.

Key Words: Residual plot, Model assessment, Bias

1490 Short-term mammary blood flow responses to changes in circulating metabolite concentrations. S.R.L. Cieslar*¹, D.R. Trout¹, T.G. Madsen², N.G. Purdie³, and J.P. Cant¹, ¹University of Guelph, Ontario, ²The Royal Veterinary and Agricultural University, Frederiksberg C, Denmark, ³University of Queensland, St. Lucia, Australia.

Mammary blood flow (MBF) is locally regulated to match nutrient delivery with demands for milk synthesis. The objective of this experiment was to determine which of the major milk precursors would elicit a MBF response when its concentration was elevated in the arterial supply, and to define the time-course of such a response. Four multiparous cows fed a TMR (CP 14.6%, ADF 27%, NDF 36%, NE_L 1.54 Mcal/kg) twice daily, ad lib or restricted to 70% of ad lib, were infused via an external iliac arterial catheter for 20 min with saline (0.09 g/min), glucose (2.2 g/min), amino acids (complete milk protein profile @2.0 g/min), triglycerides (IntralipidTM @2.0 g/min) or insulin (20 μ g/min). Base line blood flow was determined by venous dilution of arterial PAH 10, 5 and 0.5 min prior to infusion. Following the start of infusion, blood samples were collected continuously via peristaltic pump every 30 sec for the first 2 min and every 2 min for the next 28 min. Iliac plasma flow dropped 15 to 31% within the first minute of infusion of each milk precursor. During glucose and amino acid infusions, plasma flow returned to its baseline value by 20 min, but at the cessation of infusion a reactive hyperemia of 5 to 17% was observed for approximately 4 min. The triglyceride infusion continued to depress plasma flow (40 to 53%) until at least 10 min after the infusion had stopped. Insulin, on the other hand, increased iliac plasma flow by 20 to 101% during and after infusion. There were no differences in response to infusions between ad-lib and restricted feeding of the diet. The results indicate that the mammary glands modify their blood flow rate within seconds of being exposed to a new concentration of milk precursors.

Key Words: Arterial Infusion, Blood Flow, Mammary

1491 True intestinal digestibility of nitrogen, lysine and methionine estimated with sheep on intragastric infusion and by mobile bag technique. T. Hvelplund*¹, L. Misciattelli¹, F.D.DeB Hovell², and M.R. Weisbjerg¹, ¹Danish Institute of Agricultural Sciences, Denmark, ²University of Aberdeen, UK.

Lysine (Lys) and Methionine (Met) are often considered to be the most limiting amino acids in diets for high producing dairy cows. Methods for estimation of their availability in rumen undegraded protein is therefore of great importance. The true intestinal digestibility (dig) of nitrogen (N), Lys and Met was investigated for blood meal (100°C, 90h) and soybean meal (SBM) (0.8% HCHO) and for 16 hour rumen incubated residues of: SBM (120°C, 40min), SBM (160°C, 120 min), rapeseed meal, fishmeal, meat and bone meal, and peas (120°C, 40min). Intestinal digestibility was measured in lambs (n=4), fitted with a rumen cannula, an abomasal catheter and a cannula in the terminal ileum, in 4*4 latin square experiments. Cr-mordanted cellulose powder was used as flow marker. Corrections for endogenous protein secretions was based on values obtained from infusing only cellulose. The lambs received ruminal VFA infusion and abomasal protein infusions at energy intakes of 1.5*maintenance. Intestinal disappearance (dis) of N, Lys and Met

from mobile bags was determined by inserting polyamide bags (11 μ m pores size), into the duodenum and recovering the bags from the faeces, using three cannulated dry cows. Significant correlations between disappearance from mobile bags and in vivo true intestinal digestibility in sheep (n=8) was observed. Blood meal gave very low bag dis, probably due to clogging of the bag pores and results are not included. Lys values for rapeseed meal are missing for analytical reasons. The regression equations were: N-dig = 0.02 + 0.97*N-dis ($P < 0.0001$, $R^2 = 0.96$, n=7) Lys-dig = -0.19 + 1.18*Lys-dis ($P = 0.003$, $R^2 = 0.91$, n=6) Met-dig = 0.26 + 0.76*Met-dis ($P < 0.0001$, $R^2 = 0.96$, n=7) Although based on few observations the results show that the mobile bag technique can predict intestinal digestibility of crude protein and of Lys and Met.

Key Words: Amino acids, Digestibility

1492 Effects of diet on milk allantoin and its relationship with milk production in dairy goats. B.R. Min^{*1}, R. Puchala¹, and S.P. Hart¹, ¹*E (Kika) de la Garza Institute for Goat Research, Langston, OK, 73050.*

Forty-four Alpine goats (56 \pm 11 kg BW) were used to study the relationship between milk production and milk allantoin concentration with pastured dairy goats receiving different levels of concentrate supplementation. Multiparous dairy goats were divided into four groups and were supplemented with 0.66 (groups A and B), 0.33 (group C), and 0 kg concentrate (group D) per kg of milk over 1.5 kg/d. Mixed vegetative forages were rotationally grazed by the goats except for group A (confined and fed alfalfa hay). Milk production was recorded daily and milk samples were collected twice monthly from March to September, 2000 and analyzed for allantoin by HPLC. Milk allantoin (mg/d) was positively correlated ($R^2 = 0.63$; $y = 22.2x - 20.7$; $P < 0.001$) with daily milk yield (kg/d) over the four groups. Allantoin output in milk has significantly correlated with milk production range from $R^2 = 0.58$ ($y = 31.2x - 45$; $P < 0.001$), 0.62 ($y = 23.5x - 29$; $P < 0.001$), 0.53 ($y = 19.1x - 12.6$; $P < 0.01$) and 0.44 ($15x - 4.9$; $P < 0.03$) in groups A, B, C and D, respectively. Increased excretion of allantoin in milk was correlated ($R^2 = 0.44$; $y = 23.5x + 22.7$; $P < 0.001$) to concentrate DM intake suggesting that concentrate provided additional energy for increased microbial protein production with conventional mixed forage diets. Milk allantoin was positively correlated ($R^2 = 0.48$; $y = 0.37x + 23.8$; $P < 0.001$) with milk urea (mg/d), but was not correlated with blood plasma urea concentrations. Milk allantoin has the potential to be used as an indicator for microbial protein synthesis in dairy goats.

Key Words: Allantoin, Microbial protein synthesis, Milk and plasma urea

1493 Correction for microbial contamination does not alter estimates of intestinal digestibility of rumen undegraded protein. Y. G. Goh^{*1} and G. A. Broderick², ¹*Kangwon National University, Chunchon, South Korea*, ²*U.S. Dairy Forage Research Center, Madison, WI.*

Intestinal digestibility was estimated for the putative RUP from 4 protein sources: solvent soybean meal (SSBM), expeller soybean meal (ESBM), blood meal (BM) and corn gluten meal (CGM). RUP were prepared with in situ and in vitro pre-incubations. Proteins were added to dacron bags; bags were soaked in buffer then inserted into the rumens of two cannulated cows. After 16 h of in situ incubation, bags were removed, washed and dried (24 h, 60 C). Residues were harvested and ground. Rumen contents were collected from the same cannulated cows and filtered through 8 layers cheesecloth; this fluid was mixed with an equal volume of McDougall's buffer and incubated with proteins in vitro at 39 C for 16 h under CO₂. Residues were collected by filtering onto 2 layers of cheesecloth, then washed, dried (24 h, 60 C) and ground. Mixed rumen microbes also were isolated by differential centrifugation during in situ and in vitro incubations. Residues and mixed microbes were analyzed for total N and purines. Intestinal N digestibility was estimated by pepsin-pancreatin digestion. Samples (8 mg N) of residues or mixed microbes were incubated with 7.5 ml 0.01% (w/v) pepsin in 0.01 N HCl for 3 h at 39 C. Then 3.75 ml 0.2 N NaOH and 3.75 ml of 0.053% (w/v) pancreatin (0.1 M phosphate buffer, pH 8) were added and incubated for 6 h at 39 C. Incubations were stopped with trichloroacetic acid (TCA); TCA supernatants (30,000 x g) were analyzed for total soluble N. Apparent and true intestinal digestibility of RUP was computed from the total N recovered as TCA-soluble N, before and after correcting for the digestibility and amount of microbial N based on total purines. Apparent and true pepsin-pancreatin digestibility were not different (P

= 0.49). Overall RUP digestibility was different ($P < 0.01$) for protein, averaging 74.3, 71.9, 81.1 and 49.7% for, respectively, SSBM, ESBM, BM and CGM. RUP digestibility for in vitro residues (mean = 71.6%) was greater ($P < 0.01$) than for in situ residues (mean = 67.0%); however, there was a significant pre-incubation by protein interaction ($P < 0.01$).

Key Words: RUP, Pepsin-pancreatin, Intestinal digestibility

1494 In vitro effects of feed oils, ionophores, tannic acid, saponin-containing plant extracts and other bioactive agents on ruminal fermentation and protozoal activity. A. N. Hristov^{*1}, M. Ivan², and T. A. McAllister², ¹*Department of Animal and Veterinary Sci., University of Idaho, Moscow, ID 83844-2330*, ²*Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB T1J 4B1.*

The effects of various feed oils and bioactive agents on ruminal fermentation and protozoal activity were evaluated in duplicate 4-h in vitro incubations. Rumen inoculum was obtained from two heifers fed 90% rolled barley grain. ¹⁵N-casein was included in the incubation media as a N tracer. Linseed, canola, coconut, soybean and palm oils, herring meal and lecithin at 0.5, 1.0 and 2.0%, monensin (MON) at 2.5, 5 and 10 ppm and salinomycin (SAL) at 1.25, 2.5 and 5 ppm, Yucca powder (YP), Quillaja extract (QE), tannic acid (TA) and bentonite (BEN) at 0.1, 0.2 and 0.4%, and Tween 80 (T80) at 0.05, 0.1 and 0.2% were studied (n = 4). Blanks (0% or 0 ppm) were prepared for each additive. Compared to the Blank, ammonia concentration was decreased ($P < 0.05$) by MON, SAL, YP, TA and BEN. TA, MON, and SAL increased ($P < 0.05$) and BEN and YP decreased ($P < 0.05$) the total free amino acids concentration. TA reduced ($P < 0.05$) total VFA concentration and acetate:propionate ratio. BEN, TA, palm oil, QE, and SAL reduced ($P < 0.05$) carboxymethylcellulase, xylanase, and amylase activities, TA, lecithin, and QE decreased ($P < 0.05$) protozoal numbers (84% *Entodinium* spp.), and fish meal, TA, MON, and SAL reduced ($P < 0.05$) the rate of protozoal engulfment of bacteria. All levels of fish meal and SAL and the higher levels of QE and T80 depressed ($P < 0.05$) the incorporation of ¹⁵N from casein into bacterial cells. Lecithin was the only additive that effectively reduced protozoal numbers (by 27%) without impeding the growth of rumen bacteria.

Key Words: Rumen Protozoa, Oils, Bioactive Agents

1495 In vitro rates of bacterial incorporation of nitrogen fractions from ¹⁵N-labeled whole-crop barley ensiled at two dry matter contents. A. N. Hristov^{*1} and T. A. McAllister², ¹*Department of Animal and Veterinary Sci., University of Idaho, Moscow, ID 83844-2330*, ²*Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB T1J 4B1.*

Greenhouse-grown barley (*Hordeum vulgare* L) was ensiled with and without wilting and used to determine the effect of DM content at ensiling on the in vitro rate of bacterial incorporation of N fractions of whole-crop barley silage. The barley was grown in N-free soil and fertilized with ¹⁵N-ammonium sulfate. It was harvested at early-dough and ensiled in 3-L laboratory silos, either directly (at 18.2% DM) or after wilting to 30.8% DM. Average ¹⁵N-enrichment of barley silage total N was 3.743 at % exc. Freeze-dried silage samples were fractionated into soluble protein N (SP), rapidly degradable protein N (RDP), and slowly degradable protein N (SDP) corresponding to protein fractions B1, B2, and B3 in the Cornell Net Carbohydrate and Protein System. ¹⁵N-enrichment of bacterial N was measured at 18 time-points during duplicate 48-h incubations of the three N fractions in buffered ruminal fluid (n = 4). ¹⁵N-casein was used as a control N source. As determined by the 95% confidence intervals, fractions RDP and SDP did not differ ($P > 0.05$) in the rate of incorporation of their N into bacterial protein: 0.0434 and 0.0350 (RDP) and 0.0347 and 0.0436 h⁻¹ (SDP), unwilted and wilted silage, respectively. Nitrogen from SP was incorporated into bacterial N at a higher ($P < 0.05$) rate (0.2601 and 0.1573 h⁻¹, wilted and unwilted silage, respectively) than N from RDP or SDP with no effect ($P > 0.05$) of silage DM content; the highest ($P < 0.05$) rate of incorporation was observed with casein-N (0.8360 h⁻¹). In the absence of heating or spoilage, DM content of the barley silage did not alter the utilization of SP, RDP or SDP by rumen bacteria. Levels of

soluble protein in the silage may have a major impact on the rate of N incorporation and subsequent bacterial protein synthesis.

Key Words: Barley Silage, Wilting, Nitrogen Fractions

1496 Effect of barley variety and amylopectin content on bacterial utilization of ammonia-N in vitro. A. N. Hristov*, J. K. Ropp, and C. W. Hunt, *Department of Animal and Veterinary Sci., University of Idaho, Moscow, ID 83844-2330.*

The objective of this study was to determine the effect of barley variety and amylopectin content on ammonia utilization by mixed ruminal bacteria in vitro. Three consecutive, 8-hour incubations (n = 3) were conducted with barley and corn grain as substrates (10 g/L incubation media). Ruminal inoculum was obtained from a lactating dairy cow fed a 45% forage:55% concentrate diet. The ammonia-N pool was labeled with ¹⁵N-ammonium sulfate. Samples were taken at 0, 2, 4, 6, and 8 h. Three barley varieties (WestBred Gustoe, WBG; Nebula; Baronesse) and their waxy counterparts were tested in this study. The control grain was corn. All barley varieties were tested at three substitution levels: 25, 50, and 75% with the remaining being corn. Ammonia concentration was progressively reduced (P < 0.001) with incubation time but was not affected (P > 0.05) by grain source or barley amylopectin content. Across sampling points, the waxy variety of WBG effected higher (P < 0.05) bacterial incorporation of ammonia N as compared to corn (by 7.6 and 11.9%, 25 and 75% substitution levels, respectively). Across varieties, barley treatments had numerically higher (P > 0.05) ¹⁵N-enrichment of the bacterial protein compared to corn (by 4.9, 5.0, and 5.4%, 25, 50, and 75% substitution levels, respectively). At the 75% substitution level the waxy barley lines resulted in 8.1% higher (P < 0.01) ¹⁵N-enrichment of the bacterial protein than the non-waxy parent lines. At the end-point of the incubation, barley treatments tended (P < 0.1) to have higher ¹⁵N-enrichment of the bacterial protein as compared to corn, and the waxy barley lines had higher (P < 0.05) ¹⁵N-enrichment than their non-waxy parents (by 3.3, 3.6, and 5.3%, 25, 50, and 75% substitution levels, respectively). These results demonstrated that barley, as compared to corn, tended to stimulate ammonia utilization in the rumen and higher amylopectin content of barley was associated with more intensive ammonia incorporation by ruminal bacteria.

Key Words: Barley, Rumen Ammonia, Bacterial Utilization

1497 Fractionation of ammonia nitrogen isotopes by ruminal bacteria in vitro. A. N. Hristov*, *Department of Animal and Veterinary Sci., University of Idaho, Moscow, ID 83844-2330.*

The heavier of the two stable isotopes of nitrogen, ¹⁵N, is often used as an ammonia tracer in nutritional studies with ruminants assuming identical metabolism of the ¹⁴N/¹⁵N isotopes in the rumen. There is evidence that, at natural abundance level, ruminal microorganisms discriminate against ¹⁵N from ammonia, and as a result, ruminal microbial protein is depleted in ¹⁵N. However, ¹⁵N tracer studies are usually conducted at enrichment levels considerably higher than the natural abundance of ¹⁵N. It is not clear if at these levels of enrichment the magnitude of isotope fractionation is large enough to effect differences in ¹⁵N-ammonia metabolism by ruminal bacteria. To determine this, two incubations with ruminal inoculum obtained from a lactating dairy cow fed a 45% forage:55% concentrate diet were conducted (n = 4). The incubation media contained 5.3 mg/ml carbohydrates (glucose:sucrose:starch, 5:1:2). The ammonia N pool was labeled by addition of ¹⁵N-ammonium sulfate enriched at 10.7 (N10) or 20.5 (N20) at % exc. Incubations were carried out for 6 h and samples were taken at 0, 1, 2, 4, and 6 h. Bacterial pellets were isolated and analyzed for ¹⁵N-enrichment. We hypothesized that if there were a significant discrimination against ¹⁵N by ruminal bacteria, the ¹⁵N-enrichment of the bacterial N from N20 would be less than 91.6% higher than that from N10. Total VFA concentration was increasing (P < 0.001) with incubation time and was not different (P > 0.05) between the two treatments. Individual VFA and acetate to propionate ratio were not influenced (P > 0.05) by treatment. The ¹⁵N-enrichment of bacterial N was increasing (P < 0.001) with incubation time and did not differ (P = 0.266) between the two treatments (1.659 and 1.704 at % exc., N10 and N20, respectively). Source of N by incubation or incubation time interactions were not significant (P > 0.05). The results from this study indicate that,

at ¹⁵N-enrichment levels considerably higher than natural abundance, isotope fractionation by mixed ruminal bacteria is insignificant.

Key Words: Nitrogen Isotopes, Fractionation, Ruminal Bacteria

1498 Effect of Jackbean urease immunization on nitrogen recycling in mature sheep. J.C. Marini*, K.W. Simpson, A. Gerold, and M.E. Van Amburgh, *Cornell University.*

Previous experiments have shown that immunization with Jackbean urease (JBU) reduces urea hydrolysis in the gastrointestinal tract of numerous species. A consequence for farm animals is a lower energy requirement to detoxify ammonia and more energy was geared towards production. We sought to study the effects of JBU immunization on nitrogen (N)-metabolism in mature non-gravid, dry ewes. Sheep were immunized subcutaneously either with Freund's adjuvant (C, n=8), saline and 5,000 IU JBU (S, n=8) or Freund's adjuvant and 5,000 IU JBU (F, n=8) on days 1 and 22. Nitrogen balance and urea kinetic studies were performed on d32-35 and 60-63. A pelleted diet containing 16.4 %CP and 2.6 Mcal/kg ME was fed at maintenance level of intake. Immunization with JBU resulted in an increase (P < 0.05) in circulating anti-JBU IgM and IgG. Group F produced a greater IgG response than group S, but a similar IgM response. Serum from groups S and F inhibited JBU activity in vitro (P < 0.01). The results for N balance and urea kinetics were similar within a group (P>0.05) at days 32 and 60 and were pooled for further analysis. There was no effect of treatment on N balance or N excretion (P > 0.05). Urea kinetics, measured by continuous infusion of [¹⁵N¹⁵N]urea did not differ among treatments (P > 0.05). Urea production (UER), urinary urea nitrogen (UUN), urea recycled to the gastrointestinal tract (GER) and back to the ornithine cycle (ROC) averaged 25.3, 12.8, 12.5 and 5.8 g N/d, respectively. The results indicate that immunization against JBU produce a strong, and effective humoral immune response in sheep. However, immunization against JBU did not alter N-metabolism in mature, non-gravid sheep.

Item	Control	+Saline	+Freund's	sem	P<
Number of animals	8	8	8		
Body weight, kg	71.6	66.7	69.3	2.43	0.36
DMI, kg/d	1.2	1.1	1.1	0.07	0.24
N intake, g/d	31.1	29.2	29.7	0.67	0.14
Urine N, g/d	15.1	13.5	15.2	0.63	0.11
Fecal N, g/d	8.5	8.0	8.8	0.65	0.66
N balance, g/d	7.4	7.7	5.6	1.04	0.34
UER, g/d	26.4	24.1	25.5	1.30	0.44
UUN, g/d	13.2	11.8	13.3	0.55	0.11
GER, g/d	13.2	12.3	12.1	1.18	0.77
ROC, g/d	6.1	5.4	5.8	0.59	0.68
PUN, mg/dl	16.4	18.2	15.9	0.91	0.20

Key Words: Urea kinetics, N15, Urease

1499 Incorporation of nitrogen from ammonia, amino acids, peptides, or protein by mixed ruminal bacteria in vivo. A. N. Hristov*, J. K. Ropp¹, R. J. Wallace², and T. A. McAllister³, ¹Department of Animal and Veterinary Sci., University of Idaho, Moscow, ID 83844-2330, ²Rowett Research Institute, Bucksburn, Aberdeen AB21 9SB, ³Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB T1J 4B1.

To compare bacterial uptake of different forms of N in the rumen, four sources of ¹⁵N were given as intraruminal pulse doses to dairy cows in a 4 x 4 Latin square experiment. Three ¹⁵N sources were derived from ¹⁵N-casein: protein (PRO, unprocessed casein), amino acids (AA, acid hydrolysis) and peptides (PEP, enzymatic hydrolysis); ¹⁵N-labeled ammonium sulfate (NH3) was used as a control. The cows (DIM 205 17.9) fed a 43% forage:57% concentrate diet were given equal amounts of ¹⁵N from the four N sources. Representative samples (12) of the fluid- and loosely associated to the feed particles ruminal bacteria were collected for a period of 24 h and analyzed for ¹⁵N-enrichment. The areas under the ¹⁵N-enrichment curves (AUC) of bacterial N were not different (P > 0.05) between treatments. The shortest time (P < 0.05) to peak ¹⁵N-enrichment of the bacterial protein was associated with the PEP treatment, 1.65 h, followed by the PR and NH3 treatments (2.0 and 2.5 h, respectively). The AA treatment had the longest (P < 0.05) time to peak enrichment (3.1 h). The rate of incorporation of the tracer was the highest (P < .05 vs AA and NH3 and P < 0.1 vs PR) with the PEP treatment (3.58 h⁻¹) and was similar among the other treatments,

varying from 2.25 (NH₃) to 2.71 (PR) h⁻¹. The peak ¹⁵N concentration in the bacterial protein was higher (P < 0.05) with the NH₃ treatment (0.0151 at % exc.) as compared to the AA and PEP treatments (0.0099 and 0.0125 at % exc., respectively). No differences (P > 0.05) in the rate of tracer disappearance (average of 0.099 h⁻¹) or tracer half-life in the bacterial N pool were detected among treatments. Under the conditions of this trial, ruminal bacteria showed no sizable differences in the extent of incorporation of N from NH₃, AA, PEP, or PR but incorporated N from PEP at a higher rate.

Key Words: Dairy Cows, Nitrogen Source, Ruminal Bacteria

1500 Influence of methionine and/or lysine deficiencies, formulated at three different protein levels, on protein nitrogen metabolism when fed to lactating dairy cows. D. C. Weakley^{*1}, M. D. Hanigan¹, L. F. Reutzel¹, J. A. Besancenez¹, K. B. Cunningham¹, H. C. Puch¹, and B. K. Sloan², ¹Purina Mills, Inc., St. Louis, MO, ²Aventis Animal Nutrition, Alpharetta, GA.

Twelve lactating dairy cows (575 kg, 77 DIM) were assigned by parity to 6 treatments in two periods of feeding in a randomized block design, preceded by a common covariate period. Three of the treatments comprised diets formulated to be deficient in methionine (met) and/or lysine (lys), according to CPM Dairy ver. 1.0, at either 15.5, 17.5 or 19.5% dietary CP. To confirm that these diets were indeed deficient, the remaining three treatments comprised the previous diets supplemented with Smartamine M (M) and/or ML (ML) at levels necessary to establish calculated levels of 2.20 and 6.82% of metabolizable protein, as met and lys, respectively. Diets contained (DM basis) 47% corn silage and 13% alfalfa hay. Cows were allowed to adjust to their diets for a period of two weeks, followed by a 5 day total collection of milk, urine and feces. Neither DM intake (18.0±2.38 kg), milk production (32.5±4.32 kg), milk fat percent (3.36±0.281) or yield (1,070.130 kg) or milk lactose yield (1.54±0.204 kg) were significantly influenced by treatment. However, there was a significant main effect by amino acid supplementation on milk total protein (2.98 vs. 3.10%; P≤0.03), milk true protein (2.56 vs. 2.69%; P≤0.06), and milk lactose (4.82 vs. 4.76%; P≤0.09) for the deficient and supplemented diets, respectively. A greater loss of urinary N with the supplemented 15.5% CP diet, coupled with a loss of retained N but no loss in milk N, suggested a mobilization of amino acid N from body stores. Within the higher protein diets, M and/or ML resulted in a depression in urinary N loss and an improvement in N retention. Met and/or lys supplementation of deficient diets improved milk N across all protein levels.

Protein, %							Effect
M and/or ML	15.5 none	15.5 M	17.5 none	17.5 M + ML	19.5 none	19.5 ML	(P)
N intake, g/d	451 ^a	479 ^{ab}	474 ^{ab}	493 ^{abc}	589 ^c	553 ^{bc}	A (.01)
N in feces, g/d	148	156	148	152	156	141	
N in urine, % of intake	27.9 ^a	36.5 ^{abc}	39.1 ^{bc}	32.3 ^{ab}	44.7 ^c	38.5 ^{abc}	A(.06) C(.10)
N in milk, % of intake	30.6 ^{ab}	33.0 ^b	29.6 ^{ab}	31.0 ^{ab}	27.4 ^a	30.1 ^{ab}	B (.11)
N retained, % of intake	9.4 ^b	-2.1 ^a	0.04 ^{ab}	6.1 ^{ab}	1.5 ^{ab}	6.1 ^{ab}	C (.03)

Effects: A=Protein, B=M/ML, C=Protein x M/ML. Means in the same row not followed by a common letter differ (LSD, P<0.05)

Key Words: Lactating cows, methionine, lysine

1501 Effect of level of cracked Pima cottonseed in the diet of lactating dairy cows on milk yield and plasma gossypol. J. Prieto^{*1}, E. DePeters¹, P. Robinson¹, J. Santos¹, J. Pareas¹, S. Taylor¹, M. Calhoun², B. Baldwin², and S. Kuhlmann², ¹University of California, Davis, CA, ²Texas Agricultural Experiment Station, San Angelo, TX.

Lactating Holstein cows were fed one of four diets containing cracked Pima cottonseed to determine its effects on milk yield and plasma gossypol concentration. All diets contained 43% concentrate, 12% cottonseed, and 45% chopped alfalfa hay. The proportion of whole Upland cottonseed to cracked Pima cottonseed varied from 100:0, 66:34, 34:66, and

0:100 (U:P). Primiparous cows (4) were fed the diets in a 4x4 Latin square design. Multiparous cows (3) were fed the diets in a Youden square with five periods. Periods were 35d. Milk yield (kg/d), milk fat (%), and DM intake (kg/d) were not affected by the inclusion of cracked Pima cottonseed into the diet of either primiparous or multiparous cows. For primiparous cows, milk yield, milk fat, and DM intake were 36.9, 4.2, 28.3; 39.0, 3.9, 28.2; 40.3, 3.7, 29.1; and 38.2, 4.1, 27.8 for the 100:0, 66:34, 66:34, and 0:100 U:P diets, respectively. Similar data for multiparous cows were 41.9, 3.7, 33.4; 41.5, 3.7, 30.7; 41.5, 3.7, 31.9; and 38.4, 3.9, 29.3, respectively. Upland and cracked Pima cottonseed contained (% of meats DM) 1.3% and 1.7% free gossypol and 0.52% and 0.85% minus (-) isomer, respectively. Gossypol is a natural defense compound in the plant that protects it against pests and diseases, but it can have anti-nutritional quality affects when consumed by animals. Total plasma gossypol concentration significantly increased linearly with increasing proportion of cracked Pima in the diet for primiparous (4.1, 5.8, 6.9, and 8.7 ug/ml; P<0.01) and multiparous (4.1, 7.1, 9.5, and 11.7 ug/ml; P<0.01) cows. Cracked Pima cottonseed, fed at levels up to 4 kg/d, had no effect on production performance even though plasma gossypol concentrations increased sharply.

Key Words: Cottonseed, Gossypol, Cows

1502 Effects of intake and lactation on absorption and metabolism of leucine and phenylalanine by splanchnic tissues of dairy cows. C. K. Reynolds^{*1}, B. J. Bequette², J. S. Caton³, D. J. Humphries¹, P. C. Aikman¹, B. Lupoli¹, and J. D. Sutton¹, ¹University of Reading, Reading, UK, ²Rowett Research Institute, Aberdeen, UK, ³North Dakota State University, Fargo, USA.

The objective was to measure effects of intake and lactation on endogenous (END) duodenal (DUO) and ileal Leu flow and absorption and kinetic transfer of Leu and Phe across portal-drained viscera (PDV) and liver of 3 multiparous, catheterized, cannulated Holstein x Friesian cows (648 kg BW). A TMR was fed at 2 intakes (Lo and Hi) during 2 stages, late lactation (LAC) and after dry-off, giving 4 levels of DMI (Table). Measurements (mmol/h) of DUO and ileal flow and PDV blood flow and Leu and Phe sequestration (use) and transfer were made during week 4 of 5 wk intake periods using ¹³C-Phe and ¹³C-Leu (jugular vein) and ²H-Phe and ²H-Leu (DUO) infusions. ¹³C-Leu infusion continued for measurement of END Leu flow on d 6 and 7 of infusion. Milk yield was 15.4 ± 2.9 kg/d. Body flux of Leu (51.5, 63.7, 73.6 and 95.1) and Phe (20.5, 25.5, 28.7 and 33.8) increased (P < .02) with DMI. Fractional END Leu flow in the DUO (8 ± 1 %) or ileum (15 ± 2 %) was not affected. DMI and LAC increased DUO flow and thus absorption of Leu and Phe. Within stage, absorptive use of Leu and Phe was greater for Hi than Lo. PDV use of arterial Leu, but not Phe, was increased by DMI. Absorption and arterial use of Leu by PDV were greater than for Phe, while rates of absorptive use of Leu and Phe were more similar. We conclude that intake relative to requirement alters PDV sequestration and absorptive recovery of Phe and Leu.

	Dry-Lo	Dry-Hi	LAC-Lo	LAC-Hi	P-SEM	P-DMI	P-Stage
DMI, kg/d	8.0	12.0	14.9	19.4	.4		
DUO							
Leu flow	35.4	46.6	82.0	106.9	3.3	.01	.03
Ileal							
Leu flow	9.8	15.2	21.1	26.2	1.1	.01	.31
Absorptive							
Leu use	-6	6.4	-6.8	12.9	5.4	.01	.02
PDV arterial							
Leu use	15.2	21.8	28.9	31.6	6.1	.07	.56
DUO							
Phe flow	16.8	22.7	39.1	51.0	1.4	.01	.01
Ileal							
Phe flow	4.5	7.0	10.0	12.7	.7	.01	.26
Absorptive							
Phe use	2.5	6.3	-1.9	7.0	2.0	.03	.02
PDV arterial							
Phe use	3.7	3.7	8.4	10.5	2.2	.44	.26

Key Words: Absorption, Endogenous, Amino acids

1503 Peptide amino acid net flux in ruminal vein of dairy cow. D. Remond*¹, C. L. Girard², and B. Chauveau¹, ¹INRA, Clermont Fd-Theix/France, ²AAC, Lennoxville/Canada.

The objective of the study was to determine whether luminal peptides can cross the ruminal epithelium *in vivo*. Four lactating dairy cows were fitted with a ruminal cannula, catheters in the right ruminal vein and in a mesenteric artery, and a blood flow probe around the right ruminal artery. Each cow received a ruminal injection of a solution containing 320 g of peptone from casein and 24 g of glycylglycine. Blood samples were collected at -20, 0, 20, 40, and 60 min (0 was just before the injection). Plasma was deproteinized with sulfosalicylic acid. Supernate was filtered through a 3,000 Mr cut-off filter. Part of the filtrate was hydrolyzed in 6 N HCl at 110°C for 24h. The difference in AA concentration before and after hydrolysis was attributed to peptide (PAA). Control values were obtained averaging sampling times before the injection. The effect of the injection was tested using ANOVA for repeated measurements. Ruminal blood flow (68 ± 7 L/h) and arterial free amino acid (FAA) concentration ($1.89 \pm .07$ mM) were not significantly affected by the injection. Total FAA net flux in the ruminal vein ($-10.4 \pm .9$ mmole/h) was not affected by the injection. Total arterial PAA concentration linearly increased ($P < .05$) from $.15 \pm .01$ before the injection to $.21 \pm .02$ mM 60 min later. Arterial peptide Glu, Gly, and Ala increased linearly ($P < .10$), whereas peptide Pro responded in a cubic manner ($P < .05$). During the control period, total PAA net flux in the ruminal vein was not different from zero. It was not significantly affected by the injection. However, peptide Pro net flux sharply increased ($P < .01$) after the injection (from 0 to 11 μ mole/min 20 min after the injection), and responded in a quadratic manner with time. The increase in arterial PAA concentration suggested absorption of peptides from the digestive tract. The rumen contribution to this absorption appeared limited, but when high peptide concentrations are generated in the rumen, small peptides containing Pro may cross the ruminal wall.

Key Words: Rumen, Peptide, Absorption

1504 Effects of abomasal casein or essential amino acid infusions on splanchnic leucine and phenylalanine metabolism in lactating dairy cows. J. S. Caton*¹, C. K. Reynolds², B. J. Bequette³, B. Lupoli¹, P. C. Aikman¹, and D. J. Humphries¹, ¹North Dakota State University, Fargo, USA, ²University of Reading, Reading, UK, ³Rowett Research Institute, Aberdeen, UK.

The objective was to measure the effects of abomasal casein (CAA) or essential amino acid (EAA) infusion on Leu and Phe absorption and kinetics (mmol/h) in 3 multiparous, late lactation (8.9 kg milk/d), catheterized, cannulated Holstein x Friesian cows (673 kg BW). A TMR of 30 % dried lucerne, 20 % grass silage, and 50 % concentrates (DM basis) was fed hourly at 12.6 kg DM/d. Small intestinal absorption was measured on d 5 and 7 of 7-d abomasal infusions (18 L/d) of water followed by 7-d infusions of CAA or EAA equal to 800 g casein protein/d in a single-reversal design with a 3 wk interval. Portal-drained viscera (PDV) and liver (LIV) kinetic flux was measured using infused ¹³C-Phe and ¹³C-Leu (jugular) and ²H-Phe and ²H-Leu (duodenum) on d-6 of abomasal infusions. Both infusions increased ($P < .01$) body flux and true absorption of Leu (62.5 vs. 87.8 and 37.6 vs 57.9, respectively) and Phe (24.9 vs 30.1 and 18.4 vs 26.3, respectively). Infusion of EAA increased ($P < .09$) sequestration (use) of Leu (-4.9 vs 10.9) and Phe (3.5 vs 11.5) during absorption, but CAA had no effect (0.4 vs 0.2 and 6.9 vs 8.3, respectively). Use of arterial Leu by PDV was increased ($P < .06$) by infusion of EAA (21.0 vs 36.2), but not CAA (26.0 vs 28.2). Of total (absorptive + arterial) PDV use, 6 % of Leu and 66 % of Phe was from absorptive supply. Both infusions increased ($P < .03$) total PDV release of Leu (36.8 vs 56.9) and Phe (12.9 vs 22.6). Total LIV use (17.9) and release (23.0) of Leu was not affected, but infusions increased ($P < .01$) net LIV removal of Phe (8.4 vs 15.8) due to changes in total use (20.8 vs 26.2) and release (12.4 vs 10.4). Data suggest either the form (free vs protein) or composition (EAA vs CAA) of abomasal supply affect PDV utilization of absorbed Leu and Phe.

Key Words: Absorption, Gut metabolism, Amino acids

1505 Effect of type of cottonseed and gossypol intake on plasma gossypol and performance of lactating Holstein dairy cows. J.E.P. Santos*¹, M. Villasenor¹, D. Ringen¹, E.J. DePeters¹, P.H. Robinson¹, M.C. Calhoun², B. Baldwin², and J.P. Reynolds¹, ¹University of California - Davis, ²Texas A&M University.

Objectives were to evaluate the effects of type of cottonseed on lactational performance and plasma total gossypol (TG) concentration of cows. Holstein dairy cows, 856, on 3 dairy farms in central California were assigned at calving to one of two treatment diets (428/treatment) based on lactation number, calving date and previous lactation 305-d mature equivalent milk yield in a randomized complete block design. Cows were assigned 3 to 20 d after calving and remained on diets for 170 d. Cottonseed represented 10% of the diet DM, and treatments consisted of replacing whole Upland cottonseed (WUP) with a blend of WUP and cracked Pima (BUPCP) cottonseed (33:67). Whole Upland and cracked Pima cottonseed contained (% of meats DM) 1.33% and 1.66% free gossypol and 0.60% and 0.89% minus (-) isomer, respectively. Only the 809 cows that remained on the study for more than 60 days in milk (DIM) were included in the analysis. Blood samples were collected from all cows at 60 and 90 DIM for determination of plasma gossypol, but results for statistical analysis were available for 430 cows. Group DM intake did not differ between BUPCP and WUP (24.3 vs 24.4). Estimated free gossypol intake was 26.2 and 17.9 g/d for BUPCP and WUP, respectively. Plasma TG (μ g/ml) at 60 and 90 DIM was higher for cows fed BUPCP than WUP (6.80 vs 2.89, and 8.82 vs 3.37; $P < 0.001$). Proportion of plasma TG as (-) isomer was greater at 60 and 90 DIM for cows fed BUPCP vs those fed WUP ($P < 0.001$). Cows fed BUPCP had a greater increase in plasma TG from 60 to 90 DIM than those fed WUP (+2.47 vs +0.49 μ g/ml; $P < 0.001$). In BUPCP and WUP fed cows, yields of milk (39.8 vs 39.6 kg/d), 3.5% fat corrected milk (40.0 vs 39.6 kg/d), and milk fat (1.40 vs 1.39 kg/d), as well as concentrations of milk fat (3.54% vs 3.51%) did not differ. However, true protein content (2.94% vs 2.90%; $P < 0.003$) increased and milk true protein yield (1.17 vs 1.15 kg/d; $P = 0.11$) tended to increase for cows fed BUPCP vs those fed WUP. Replacement of whole Upland cottonseed with a blend of whole Upland and cracked Pima cottonseed increased plasma TG, as well as the proportion of plasma TG as (-) isomer. Yields of milk and milk components were not affected, but milk protein content was improved.

Key Words: Cottonseed, Plasma gossypol, Dairy cows

1506 Use of an inhibitor *in vitro* method to determine protein degradability coefficients in the NRC (2001) protein evaluation system. J.R. Newbold*¹, B. De Wannemaeker¹, and P. Gerardy¹, ¹Provimi Research and Technology Centre.

NRC(2001, Nutrient Requirements of Dairy Cattle, Seventh Revised Edition) recommends the *in situ* (IS) technique to measure rumen degradable protein (RDP, % of CP), calculated from immediately-degraded N (A), slowly-degraded N (B), undegradable N (C) and rate of degradation of B (Kd). Our objective was to predict these values using an inhibitor *in vitro* (IIV) method. Foods were: solvent-extracted soybean (n=2), sunflower (n=2) and canola meals, corn gluten feed, corn gluten meal, palm kernel expeller meal (PK), potato protein (PP) and a commercial bypass protein ('Aminolac', Provimi BV, Rotterdam). Soy, canola and sunflower meals were solvent extracted. Foods in polyester bags were incubated in rumens of two non-lactating cows for 0, 3, 6, 24, 48 and 210h. In IIV tests, intact foods and a fraction soluble in phosphate buffer were incubated with rumen fluid and inhibitors of deamination and microbial growth for 4h. TCA-soluble N at 0h gave a measure of fraction A. Calculations assumed passage rate=6%/h. Fraction A was higher ($P=0.025$) for IS than IIV (19.6% and 12.3%, $se=2.76$). This was marked for PP (A IS=31.2%, A IIV=2.2%), indicating loss from bags of N in small particles. Excluding PP data, RDP IS was not different from RDP IIV (means=48.8% and 51.5%, $se=3.48$, $P>0.05$). $RDP IS = 9.2 + 0.77(RDP IIV)$, $r^2=0.75$. Fit of the model describing IS data was poorer for PK than other foods. After exclusion of PK, $RDP IS = 13.3 + 0.74(RDP IIV)$, $r^2=0.87$. RDP IIV of soluble N <100% for soybean, sunflower and canola meals, suggesting that the IS method overestimates RDP for these foods. The IIV method can be used to measure RDP as defined by NRC(2001). The IIV method has advantages where particle size is small or where part of fraction B is soluble in rumen fluid.

Key Words: Protein, Degradability, Bypass

1507 Intake and production by Holstein cows fed different amounts and sources of supplemental protein prepartum and postpartum. J.P. Underwood*, J.K. Drackley, and J.H. Clark, *University of Illinois, Urbana, IL*.

Improving metabolizable protein supply in late-gestation cows might benefit health and subsequent milk production. Sixty pregnant non-lactating cows were blocked by expected parturition date and assigned to one of three prepartum diets: 12% CP, soybean meal (SBM) supplement (LSB); 15% CP, SBM supplement (HSB); and 15%CP, animal-marine protein (AMP) supplement. Diets were formulated to supply an estimated 927, 981, and 1100 g/d of metabolizable protein, respectively. Cows were fed diets from 21 d prepartum to parturition. After parturition, cows were assigned to one of two diets containing 18% CP (SBM supplement or AMP supplement); thus, treatments were in a 3 x 2 factorial arrangement. Dry matter intake (DMI) and milk production were recorded for 63 d postpartum. Prepartum DMI did not differ among LSB, HSB, and AMP (10.9, 11.8, and 11.7 kg/d, respectively). Postpartum DMI was similar between groups fed SBM or AMP (19.9 and 18.9 kg/d). Cows fed AMP postpartum produced 36.4 kg/d of milk vs. 34.4 kg/d for cows fed SBM ($P=0.21$). Milk fat and protein percentages were not affected by prepartum or postpartum diets. Cows fed AMP tended ($P=0.10$) to produce more 4%fat-corrected milk (FCM) than SBM supplemented cows (33.8 kg/d vs. 31.8 kg/d). An interaction of protein source (at 15% CP) and postpartum diet was detected for FCM ($P<0.05$); means were 30.8, 34.7, 33.8, and 32.0 kg/d for cows fed HSB prepartum, SBM postpartum; HSB prepartum, AMP postpartum; AMP prepartum, SBM postpartum; and AMP prepartum, AMP postpartum, respectively. Efficiency (FCM/DMI) was greater ($P<0.05$) for cows fed AMP postpartum (1.88 vs. 1.70). An interaction of postpartum diet by week ($P<0.05$) indicated that cows fed AMP postpartum lost more body weight than cows fed SBM. Body condition score (BCS) was not affected by diets. Increasing the amount or source of protein fed to nonlactating cows during the last 21 d prepartum did not affect DMI, milk production, or BCS.

Key Words: Protein, Dry Period, Transition Cow

1508 Effect of barley and rapeseed meal supplementation on amino acid profile of microbial fractions and postruminal amino acid supply in lactating dairy cows fed grass-red clover silage. M. Korhonen*, S. Ahvenjrvi, A. Vanhatalo, and P. Huhtanen, *MTT, Agrifood Research Finland*.

Four ruminally cannulated dairy cows were used to study AA composition of omasal canal digesta, bacterial, and protozoal fractions as well as omasal canal AA flow as affected by diet. Cows were given grass-red clover silage alone (S), supplemented with 6 kg of barley (B), with 2.1 kg of rapeseed meal (R), or with 6 kg of barley and 2.1 kg of rapeseed meal (BR) according to 4x4 Latin Square design with 2x2 factorial arrangement and 21 d periods. During last week of each period silage intake was restricted to 95% of ad libitum intake. Omasal canal DM flow was measured using triple marker (Co, Yb, INDF) method. Amino acid flow entering the omasal canal was calculated based on DM flow and AA composition of reconstituted digesta. Liquid- (LAB) and particle- (PAB) associated bacteria were isolated from reticular digesta and protozoa from omasal canal digesta. Microbial protein flow was determined by using ^{15}N as a microbial marker. Omasal canal AA flows were 1452, 1756, 1754, and 2008 g/d (SEM 92.7) on diets S, B, R, and BR, respectively. On diet R, increase in AA flow was of nonmicrobial, whereas on diet B it was mainly of microbial origin. This changed slightly AA profile of digesta, and resulted in a better marginal utilization of AA for milk protein synthesis (55 vs 44%) on diet R than on diet B. Flows of LAB- and protozoa-NAN were 100, 159, 123, and 173 g/d (SEM 12.4) and 9, 25, 9, and 20 g/d (SEM 4.4) on diets S, B, R, and BR, respectively. Diet had only minor effect on AA composition of microbial fractions, but differences were observed between LAB and PAB for 10 out of 19 AA studied, and also between bacteria and protozoa for 15 out of 17 AA studied. Differences in AA composition and flows of various microbial fractions had, however, only small effect on AA profile of microbial protein. Consequently, AA composition of postruminal digesta seemed to be affected mainly by proportions of microbial and nonmicrobial proteins.

Key Words: Amino Acids, Bacteria, Protozoa

1509 Effect of type of dietary protein on mRNA expression for urea cycle enzymes in lactating dairy cows. J.R. Townsend*, S.M. Crowder, J.C. Velez, and S.S. Donkin, *Purdue University, West Lafayette, IN*.

Liver metabolism adapts to changes in dietary protein level and amino acid profiles. The objective of this study was to determine the response in liver of lactating dairy cows to changes in the type of protein in the diet. Thirty-six Holstein dairy cows were fed a diet containing 18.5% crude protein (CP) and 1.76 Mcal/kg NEL and either 12.6, 11.7, or 10.9% rumen degradable protein (RDP). The quantity of RDP and rumen undegradable protein (RUP) in the diet was manipulated by altering the amounts of soybean meal and heat-treated soybean meal used in the ration. Diets were fed for 11 weeks, milk production and feed intake were measured daily, and milk composition was determined weekly. Liver biopsies and blood samples were obtained from a subset of 16 cows during weeks 2, 5, 8, and 11. Argininosuccinate synthetase (AS) and carbamoyl phosphate synthetase I (CPS-I) mRNA were measured in liver biopsy samples and blood was used for plasma urea nitrogen (PUN) analysis. Milk production was 34.8, 38.2, 37.1 1.8 kg/day, dry matter intake was 23.8, 25.8, 25.4 .82kg/day for 12.6, 11.7, and 10.9% RDP respectively. Protein intake exceeded requirements for CP, RDP, and RUP. Feeding 10.9% RDP decreased ($P<.05$) MUN and PUN compared to the other two diets. A time on experiment effect ($P<.05$) was observed for AS and CPS-I mRNA and PUN. There was a tendency ($P<.10$) for correlation between PUN and dry matter intake ($r=.22$), crude protein (CPI) ($r=.22$), and RDP ($r=.32$) intake. Abundance of CPS-I and AS mRNA were correlated ($P<.05$, $r=.76$) as were MUN and PUN ($r=.56$), and MUN and DMI ($r=.50$). The intake of RDP was correlated ($P<.05$) with MUN ($r=.62$), and CPI was correlated ($P<.05$) with MUN ($r=.50$). The data indicate that when dietary protein is overfed, mRNA for urea cycle enzymes are closely related to other measures of protein utilization such as MUN and PUN. Overfeeding protein in this experiment may have masked any effects of RUP or RDP on mRNA for urea cycle enzymes.

Key Words: Liver, Gene expression, Protein

1510 Responses of dairy cows fed grass silage-cereal diet to increased supply of histidine provided either by abomasal infusion of histidine or dietary inclusion of rape seed meal. A. Vanhatalo*, P. Huhtanen, M. Korhonen, and T. Varvikko, *MTT Agrifood Research Finland, Jokioinen, Finland*.

A 4x4 Latin square was conducted with four cows to investigate responses to supplementation of grass silage-cereal diet with His supplied either with abomasal infusion of 6.5 g/d His (H), 1.5 kg/d of rape seed meal (RSM) and 3.25 g/d of His (HR) or 3 kg/d of RSM (R). Each treatment was designed to provide an additional His supply of 6.5 g/d. The design was aimed to evaluate how much of the response to RSM could be explained by the response to His alone. The control diet (C) consisted of grass silage (18.9% CP) ad libitum and 9 kg/d of a cereal based concentrate (12.6% CP). Glucose was infused abomasally at a rate of 250 g/d on each treatment. Treatments had no significant effects on silage or total DMI, rumen fermentation, microbial protein production, or OM digestibility of diets ($P>.05$). Milk yields for the treatments C, H, HR and R were 32.5, 31.8, 33.4, and 33.2 kg/d (SEM 0.23), protein yields 1080, 1068, 1126 and 1132 g/d (SEM 16.3), and lactose yields 1643, 1611, 1692, and 1680 g/d (SEM 11.2), respectively. Increases of these parameters were linear or quadratic ($P\leq.03$) with increasing amount of RSM. Treatments did not affect milk composition except for milk urea, which increased with increasing amount of RSM ($P<.05$). Arterial plasma concentration of urea, and essential and branched chain amino acids (AA) increased linearly ($P<.03$) with increasing amount of RSM. Arterial glucose was not affected by the treatments, but concentrations of BHBA and insulin increased ($P<.05$), and NEFA decreased due to His supplementation. The production potential of cows was realized exceptionally well with the basal diet because production responses to RSM were less than half of those usually derived with RSM on grass silage diets. Also, opposite to earlier findings, arterial concentration of His on the basal diet ($>42 \mu\text{M}$) was higher than expected suggesting that some other nutrient or AA but His limited milk production in the present study.

Key Words: Grass silage, Histidine, Dairy cow

1511 A comparison of different methods to measure milk urea nitrogen. R.A. Kohn*, K.R. French, and E. Russek-Cohen, *University of Maryland, College Park.*

Milk urea nitrogen (MUN) is measured routinely on dairy farms to evaluate protein nutrition. The objective of this study was to compare methods that are currently used by Dairy Herd Improvement Association (DHIA) labs for analysis of MUN. Two replicate samples from each bulk tank on 10 different dairy farms were sent to 14 DHIA labs throughout the U.S. for MUN analysis. The mean MUN of all samples was 14.0 mg/dl. The lowest farm averaged 6.8 mg/dl and the highest averaged 19.1 mg/dl across labs. For the Foss 6000, Bently Chemspec, Skalar and CL 10 methods, greater than 98% of the variation in measured MUN was attributed to farm to farm differences. This result was desired because it indicates that labs can consistently quantify the variation that occurs among farms. For the Foss 4000 system, less than 60% of the variation in MUN was attributed to farm to farm differences. The remaining variation was attributed to lab differences (33.8%), lab by farm interaction (5.7%), and random error (1%). The results for each method of MUN analysis were compared to reference values determined by CL 10. The difference from the CL 10 method was represented as the root mean square prediction error (RMSPE) where a smaller number indicates greater accuracy. The RMSPE for the Foss 4000, Foss 6000, Bently, and Skalar methods were: 2.48, .63, .65 and .86 mg/dl respectively. The error of the Foss 4000 relative to the CL 10 reference was further partitioned to mean bias (0.7%, $P > .1$), slope bias (51.7%, $P < .01$), lab bias (13.7%, $P < .01$), lab by slope interaction (19.6%, $P < .01$) and residual error (14.3%). The Foss 4000 system underestimated the higher values while overestimating the lower values, and it was not consistent across labs. Thus, this method should not be used to estimate urinary N or protein adequacy. For the other methods, differences from the CL 10 were slight and would not have affected predictions of urinary N or expected MUN.

Key Words: Milk urea nitrogen, Analysis methods

1512 A role for rumen degraded protein in regulating intake rate of digested fiber. W. C. Ellis*¹, J.H. Matis¹, Dennis Herd¹, H. Lippke¹, F.M. Rouquette¹, D. P. Poppi², and R. J. Wallace³, ¹Texas A & M University, ²University of Queensland, ³Rowett Research Institute.

It was hypothesized that insufficient flux of rumen degraded CP, RDP, successively limits growth rate of NDF digesting bacteria, rate of digestion of potentially digestible NDF (PDF) and ruminal turnover and intake rate of digested PDF (DF). Intake rate of DF should then be positively related to ruminal flux proportions of RDP/DF required to optimize turnover of rumen load of DF by digestion and by escape. An experiment was conducted to measure these hypothesized responses in dynamics of intake and digestion of PDF. Ten lambs were fed diets providing ratios of either 0.11 or 0.24 of RDP/DF achieved by use of mineral supplemented cottonseed hulls alone or supplemented with cottonseed meal. The DF and voluntary intake was measured for each of the five lambs per diet. Rumen load of indigestible NDF (IF) was then measured at slaughter two h after an AM feeding. Ruminal turnover of PDF was assumed equal to turnover of IF computed as mean intake rate of IF preceding slaughter divided by rumen load at slaughter. Lambs receiving the 0.11 vs. the 0.24 RDP/DF diet exhibited greater live weight gains and plasma concentrations of amino acids and reduced levels of plasma 3-methylhistidine; responses reflecting greater flux of metabolizable amino acids and deposition rate. Lambs receiving diets of 0.24 vs. 0.11 RDP/DF had greater ($P < 0.05$) rumen load and turnover rates of IF and greater ($P < 0.05$) rates of digestion of PDF and voluntary intake of DF. Buoyancy of feed fragments derived from rate of digestion of PDF was postulated to be the metabolically related force constraining turnover rate of PDF (assuming turnover of PDF equals turnover rate of IF). Assuming 70% ruminal degradation of dietary CP, the results were compared to recomputed literature data from four other related experiments. Results of these five experiments conform to expectations that products of RDP nutritionally limit growth rate of PDF digesting bacteria and, consequently, intake rate of DF over the range of RDP/DF observed.

Key Words: Rumen, Protein, Intake

1513 The prediction of microbial protein supply to growing lambs fed raw and dry roasted legume seeds as protein supplements from the urinary excretion of purine derivatives. P. Yu*¹, L. Boon-ek², A.R. Egan², and B.J. Leury², ¹Department of Animal and Poultry Science, University of Saskatchewan, Canada, ²Institute of Land and Food Resources, University of Melbourne, Australia.

Urinary excretion of purine derivatives was used to estimate the microbial N supply to growing lambs in the experiment designed to examine the effect of supplementation and dry roasting whole lupin (*lupinus angustifolius*) seeds (WLS) and whole faba (*vicia faba*) beans (WFB) as protein supplements on rumen microbial N supply to the host animal. Lambs were fed a fixed quantity of oat straw and alfalfa hay plus a daily supplement of either of the following: no legume seeds (CTRL), raw WLS, roasted WLS, raw WFB, or roasted WFB. Legume seeds were dry roasted at 150C for 45 min (as the desirable conditions in the previous study). All diets were isonitrogenous (15.9% CP). In the supplemented diets, about 55% of protein was supplied by WLS or WFB protein. The amount of legume seeds per metabolic liveweight (WLS: 20 g/LW^{0.75}; WFB: 25 g/LW^{0.75}) was kept the same throughout. At the end of feeding experiment, the excretions of the purine derivatives, allantoin, uric acid plus hypoxanthine and xanthine, were measured after total urine collection during N balance trial to estimate microbial N supply to the duodenum. The results show that lambs fed the five dietary treatments with similar total DM and N intakes, averaging 1158 and 30 g/d across treatments, but different BCP (= rumen bypass feed protein), DVE (= truly digested protein in the small intestine) and OEB (= degraded protein balance) values did not differ in urinary excretion of purine derivatives (averaging 13.0 mmol/d) (allantoin, averaging 10.5 mmol/d; uric acid plus hypoxanthine plus xanthine, averaging 2.5 mmol/d), total purine derivatives absorption (averaging 15.4 mmol/d), microbial N supply (averaging 11.2 g N/d) to the duodenum and efficiency of microbial synthesis (averaging 23.7 g of N/ kg DOMR (digestible OM fermented in the rumen) to growing lambs. No relationships were detected between the estimated protein values of BCP, DVE and OEB and microbial N supply. These results indicated that dry roasting and supplementation had no significant effects on the flow of microbial N into the duodenum.

Key Words: Purine derivatives, Microbial N supply, Lamb

1514 A Role for Ruminally Degraded Protein in Determining Yield and Efficiency of Rumen Efflux Microbial Protein. W.C. Ellis*¹, Dennis Herd¹, J.H. Matis¹, H. Lippke¹, F.M. Rouquette¹, D.P. Poppi², and R. J. Wallace³, ¹Texas A & M University, ²University of Queensland, ³Rowett Research Institute.

Evidence at the microbial level suggests that optimal growth rate and efficiency of the rumen microbial ecosystem requires specific carbon structures derived from ruminal degradation of dietary protein. However, such a requirement at the dietary level remains obscure. The present objective was to evaluate relationships between flux of ruminally degraded entities upon rumen microbial protein efflux, MPE. Data were computed from literature sources reporting MPE and rumen flux of CP (RDP), NDF (RDF) and of non-structural carbohydrates (RNSC), the latter being computed as OM - [(NDF+lipids+CP)0.8]. Ruminal flux of degraded carbohydrates, RDCHO, was computed as the sum RDF+RNSC and energetic efficiency of MPE computed as MPE/RDCHO. The database consisted of 154 treatment means from 36 experiments with data from both non-lactating and lactating cattle and mixed and all forage diets. In order for data with sheep to be expressed, all variables were expressed as daily flux per kg BW and relations between MPE as the dependent variable and daily flux of ruminally degraded nutrients as the independent variables were examined. Variations in MPE were equally ($R^2 = 0.79$ to 0.89) associated with ruminal flux of truly digested OM, RDNSC and RDP. Variations in efficiency of MPE/RDCHO were primarily associated with flux proportions of RDP/RDF ($R^2 = 0.74$). Variations in MPE and MPE/RDCHO were most correlated with flux of RDP and RDF. Thus MPE/RDF was logically and statistically highly correlated with RDP/RDF in animals receiving either forage or mixed diets ($R^2 = 0.89$ and 0.9 , respectively). These associations suggest that variations in MPE were related to the product of flux of RDCHO and energetic efficiency MPE was determined by flux proportions of RDP/RDF. A dietary essential role for deaminated products of amino acids is implicated specifically to enhance growth rate of RDF

digesting bacteria. Variations in RDP/RDCHO were only of a sufficiently range in the forage data to develop reliable prediction equations for MPE: Daily MPE, g/kg BW = daily RDCHO g/kg BW (0.04+0.62 (RDP/RDCHO)); R square=0.83

Key Words: Rumen, Microbial, Protein

1515 Effect of type of cottonseed and gossypol intake on reproduction and health of lactating Holstein dairy cows. J.E.P. Santos*¹, M. Villasenor¹, C.H. Holmberg¹, D. Ringen¹, E.J. DePeters¹, P.H. Robinson¹, B. Bretz¹, and P.W. Jardon², ¹University of California - Davis, ²Visalia, CA.

Objectives were to evaluate the effects of type of cottonseed on reproductive performance and health of dairy cows. Holstein dairy cows, 856, on 3 dairy farms in central California were assigned at calving to one of two treatment diets (428/treatment) based on parity, calving date and previous lactation 305-d mature equivalent milk yield in a randomized complete block design. Cows were assigned 3 to 20 days in milk (DIM) and remained on diets for 170 d. Cottonseed represented 10% of the diet DM, and treatments consisted of replacing whole Upland cottonseed (WUP) with a blend of WUP and cracked Pima (BUPCP) cottonseed (33:67). Estimated free gossypol intake was 26.2 and 17.9 g/d for BUPCP and WUP, respectively. Estrous was synchronized with two injections of PGF2a (Lutalyse) 14 d apart. Cows were inseminated after the second PGF2a injection (> 44 DIM). Within each dairy, the same technician artificially inseminated all the cows with semen from sires randomly distributed across the two treatments. Pregnancy diagnosis was performed 35 to 45 d after AI, and pregnant cows were reconfirmed at 170 DIM. A postmortem diagnosis was performed in cows that died. Treatment did not affect DIM at first AI and it averaged 58.7 d. Estrus detection after the second PGF2a injection tended to be greater for BUPCP vs WUP (56.9 vs 50.9%; $P < 0.09$). In BUPCP and WUP fed cows, first AI conception rate (29.4 vs 28.2%), percentage of pregnant cows at 170 DIM (74.8 vs 79.4%), and incidence of cystic ovarian disease (8.1 vs 6.1%) did not differ. Average days open for pregnant cows was similar between BUPCP and WUP (91.0 vs 89.8). However, incidence of abortions was greater for cows fed BUPCP vs WUP (8.5 vs 4.1%; $P < 0.05$). Percentage of cows dead or sold was similar, and DIM when cows left the study (dead or sold) did not differ between treatment groups. Nevertheless, cows fed BUPCP tended to have a greater incidence of lameness (17.6 vs 13.1%; $P < 0.08$), but a lower incidence of mastitis (10.6 vs 18.6%; $P < 0.003$) than those fed WUP. No dead cow showed any lesions compatible with gossypol toxicity. Replacement of whole

Upland cottonseed with a blend of whole Upland and cracked Pima cottonseed did not affect reproduction and health of lactating Holstein dairy cows.

Key Words: Cottonseed, Gossypol, Dairy cows

1516 Bloodmeal and fishmeal addition to receiving diets. J. W. Lehmkuhler*¹, E.E.D. Felton¹, C.J. Fu¹, and M. S. Kerley¹, ¹University of Missouri.

Two experiments were conducted to evaluate the response of a 1:1 bloodmeal and fishmeal combination (BMFM) in receiving cattle. In experiment one, Simmental calves (six heifers and 30 steers) were randomly assigned to nine pens. Cattle were fed a corn and corn silage based diet. Treatments included a soybean meal (SBM) control, low, and high BMFM. Dietary CP was calculated to be 13%, 13%, and 16%, respectively. Intake was restricted during the first 21 d to model low intake responses of newly received cattle to ruminally undegradable protein (RUP) and was increased the following 25 d. Initial, mid-term, and final weights were similar ($P > .1$) among treatments averaging 347, 351, and 380 kg, respectively. Similarly, no treatment differences were observed for ADG or GF during the 21d restriction period, step-up period, or for the entire receiving period. In experiment two, sixty Angus-sired calves were randomly assigned to twelve pens in a 2X2 factorial design of treatments. Treatments investigated were level of crude protein (low-13%CP vs. high-16%CP) and form of protein (SBM vs. BMFM). Diets consisted of corn, late-bloom alfalfa hay, and the pelleted supplemental treatments. Diets were fed at similar levels for all treatments for 21 d. No treatment differences ($P > .1$) were observed for initial and ending weights (305 and 330 kg, respectively). Form or level of protein had no effect ($P > .1$) on ADG. Average daily gain for treatments were 1.1, 1.2, 1.3, and 1.2 kg/d for the low SBM, low BMFM, high BMFM, and high SBM, respectively. Due to the similar intakes and lack of response in ADG, treatment differences were not significant for GF and averaged 0.16. Though not statistically significant, a numerical difference in the interaction for FG was observed. Feed conversions were 9.1, 6.9, 6.9, and 7.7 for the low SBM, low BMFM, high BMFM, and high SBM, respectively. We inferred that addition of RUP and level of protein may alter performance and efficiency of receiving cattle. Further studies are warranted to investigate the relationship between level and form of protein in relationship to energy intake of newly arrived cattle.

Key Words: feedlot, receiving, ruminant

AMSA Graduate Student Research Posters (M.S. and Ph.D. Divisions) and AMSA General Abstracts

1517 Oxymyoglobin and lipid oxidation in α -tocopherol supplemented pork liver microsomes. S Lee*, A L Phillips, and C Faustman, *University of Connecticut, Storrs, CT.*

The biological antioxidant, α -tocopherol, has been used endogenously or exogenously to delay oxymyoglobin (OxyMb) and lipid oxidation in meat. α -Tocopherol quenches free radicals originating from lipid oxidation and this, in turn, appears to protect OxyMb against oxidation. In muscle membranes, α -tocopherol is located close to membrane-bound enzymes that generate free radicals, and acts to protect membrane lipids by scavenging free radicals. An OxyMb porcine microsome model was used to study the effects of α -tocopherol on OxyMb or lipid oxidation *in vitro*. Pork liver microsomes were isolated from pigs fed either a control or vitamin E-supplemented diet (Phillips et al., 2001, Meat Sci., In press), and combined with horse heart OxyMb prepared by hydrolysate-mediated reduction. OxyMb (0.15 mM) was incubated with microsomes (1mg/ml) at 25 and 37 °C, pH 5.6. During incubation, OxyMb oxidation was measured spectrophotometrically by use of a diffuse-integrating sphere, and percent metmyoglobin (MetMb) was calculated. Lipid oxidation was measured by a thiobarbituric acid reactive substances (TBARS) method. MetMb formation increased with increasing temperature, and was greater at 37 °C than at 25 °C ($P < 0.05$). At 37 °C, MetMb reached 50% within 2 hours incubation, whereas 8 hours was required at 25 °C. There was no significant effect of α -tocopherol on delaying OxyMb oxidation either at 25 or 37 °C. Lower TBARS were observed in microsomes from vitamin E-supplemented than control pork livers ($P < 0.05$). These results differ from those observed with beef mus-

cle microsomes where both OxyMb and lipid oxidation were delayed with elevated α -tocopherol levels.

Key Words: Oxymyoglobin, Lipid oxidation, α -Tocopherol

1518 Effect of high oil corn and vitamin E supplementation on beef steak case-life properties. M.S. Eibs*¹, B.J. Johnson¹, D.M. Wulf¹, B.C. Shanks¹, and T.A. Wittig¹, ¹South Dakota State University.

The objective of this experiment was to investigate the effects of high oil corn and vitamin E supplementation on steak case-life properties. Steers ($n = 84$) were fed a high concentrate diet consisting of either typical corn (C: 79.5% of ration) or high oil corn (HOC: 79.5% of ration) for 112 days with (+E) or without (-E) vitamin E supplementation during the last 50 d (1,000 IU/hd/d). Steaks (2.54 cm thick) were removed 24 h postmortem from the 12th rib and utilized in retail display panel (RDP), thiobarbituric reactive substances determination (TBARS), and tocopherol analysis. Two storage treatments were used prior to RDP: 1) domestic chilled (DC), chilled storage for 13 d postmortem; and 2) export chilled (EC) chilled storage for 34 d postmortem. Steaks were appraised for 9 d (d 0 to 8) under simulated retail meat display conditions by a 5-member panel and color was measured with a Minolta colorimeter. On d 8, TBARS of RDP samples were determined. HOC grain contained more ($P < 0.05$) α - and γ -tocopherol than C grain (14.62 and 84.90 vs 8.01 and 41.68 ppm). Ribeye steaks +E contained higher ($P < 0.05$) levels of α -tocopherol than ribeye steaks -E. Steaks from HOC had higher concentrations of γ -tocopherol than C steaks (P

<.01). Steaks -E had higher concentrations of γ -tocopherol than steaks +E ($P < .03$). Rate of discoloration, as appraised by RDP, was slower ($P < .05$) in HOC+E steaks than in HOC-E steaks for DC and EC storage treatments. In both the DC and EC storage treatment steaks +E had lower ($P < .01$) TBARS than steaks -E. These data suggest supplementing vitamin E while feeding high oil corn in diets for finishing beef steers does not improve beef steak case-life properties beyond typical corn diets with vitamin E supplementation.

Key Words: High Oil Corn, Beef, Tocopherol

1519 Evaluation of growth rate, carcass composition and meat quality of Berkshire- and Yorkshire-sired progeny. M.J. Ritter*, C.P. Allison, S.R. Debar, J.M. Scheffler, R.J. Tempelman, and M.E. Doumit, *Michigan State University, East Lansing, MI.*

Our objective was to examine differences in growth, carcass composition and meat quality traits of crossbred pigs. Berkshire-sired (B; n=16) and Yorkshire-sired (Y; n=16) progeny were blocked by gender, sire and weight at approximately 86 kg. Over the last 27 d of the finishing period, average daily gain (ADG) of Y pigs was 22% greater than B ($P < .02$). Pigs were harvested at a commercial abattoir on two days. Carcass weights did not differ by breed, but Y carcasses were leaner at the tenth rib and last lumbar vertebra, produced heavier hams, more pounds of fat-free lean and lighter bellies than B ($P < .01$). *Longissimus* muscle (LM) temperature and pH were measured at 20, 45, 180 min, and 24 h postmortem. Berkshire-sired pigs had higher 180 min and 24 h pH values. Loin chops from B had higher subjective loin color and marbling scores, and lower Minolta CIE L* values on d 1 postmortem ($P < .05$). A harvest date by breed interaction existed for suspension drip loss and 20 min LM temperature ($P < .05$). This interaction is attributed to disproportionate increases in temperature and drip loss of Y LM on the second harvest day. Berkshire-sired pigs had lower fluid loss from vacuum packaged loin sections stored at 4°C for 7 d than Y ($P < .003$). Yorkshire-sired pigs grew faster and produced more fat-free lean than B, but B pigs had more desirable color and better water holding capacity, presumably due to a more gradual rate of pH decline and higher ultimate pH.

Key Words: Meat Quality, Carcass Composition, Growth Rate

1520 Mechanisms of vitamin D3 on tenderness of lamb. C. T. Boleman¹, J. W. Savell^{*1}, W. S. Ramsey¹, and R. K. Peel¹, ¹Texas A&M University.

Two trials were conducted to determine the effects of Vitamin D₃ (VITD) on the tenderness of lamb: Trial 1 evaluated ionized Ca levels in blood serum, percent intake (PI), and total gain (TG) on 26 rams assigned randomly to one of eight treatments of VITD. These treatments were supplemented at one of four levels: 0 (SO); 250,000 IU of VITD (S250); 500,000 IU of VITD (S500); or 750,000 IU of VITD (S750) or administered as a bolus of 0 (B0); 250,000 IU of VITD (B250); 500,000 IU of VITD (B500); or 750,000 IU of VITD (B750) for four days. There were no ($P > 0.05$) differences at each day for treatment type for ionized Ca levels in blood serum. Rams assigned to the S500 treatment had lower ($P < 0.05$) PI and TG than other supplemented groups. Trial 2 evaluated carcass composition by analyzing Warner-Bratzler shear (WBS) values of chops from the longissimus lumborum (LL), semitendinosus (ST), semimembranosus (SM), and biceps femoris (BF) from each of the 40 carcasses. Forty feedlot lambs were assigned randomly to one of two treatments of a control (CONT) (n=20) or 750,000 IU of VITD (n=20) and fed in a mock feedlot environment for four days before slaughter. There were no differences ($P > 0.05$) for ionized blood Ca levels in blood serum. Vitamin D₃ content in livers and kidneys differed ($P < 0.01$) between VITD vs. CONT (livers - 504.54 vs. 27.13 and kidneys - 1530.20 vs. 21.18 ng/g vitamin D₃). Carcasses from VITD treated lambs had less ($P < 0.05$) average fat thickness (AFT). (0.68 vs. 0.84 cm) and an increase ($P < 0.05$) in overall conformation (OCS). The four muscles were removed, fabricated into chops, assigned randomly to a postmortem aging day of 5 (AG5), 10 (AG10), or 15 (AG15) for WBS determination. Chops from the LL did not differ ($P > 0.05$) for WBS values for CONT vs. VITD for all aging days; however, chops from the SM and ST had ($P < 0.05$) lower WBS values for VITD vs. CONT at 5d aging. Activation and acceleration of calpain dependent proteases could be responsible for

lower WBS values for AG5 chops however, VITD regulators are most likely preventing VITD from increasing Ca levels in blood.

Key Words: Lamb, Vitamin D, Tenderness

1521 Lean lamb production: Bioelectrical impedance as a lean tissue evaluation method. P. T. Berg^{*1}, T. C. Faller², and M. N. Maddux¹, ¹North Dakota State University, Main Station, Fargo, ²North Dakota State University, Hettinger Research Extension Center.

The objective was to evaluate Bioelectrical Impedance (BIA) to predict weight of retail product (LN) in lambs. Carcasses (n=217) were subjected to BIA evaluation 24 h post slaughter. Resistance (Rs), reactance (Xc), length (L) between electrodes and temperature (T), and standard carcass data was recorded. Carcasses were reduced to wholesale cuts according to NAMP specifications. Cut weights were recorded before and after fat was trimmed from shoulder, rack, loin and leg. Lean was exposed over at least 85% of the surface. Sum of the four trimmed wholesale cuts (ACT) was used as dependant variable. An anatomical measurement (LNa) and a BIA based prediction formula (LNb) were developed (Proc. GLM of SAS). Formulas are: LNa = 4.8 + (0.58*c carc wt) + (1.39*REA) - (7.36*12th rib fat) - (5.87*body wall). LNb = 6.72 + (0.4818*c carc wt) - (0.0314*Rs) - (0.0481*Xc) + (0.254*L) + (0.0223*T). R² for LNa = 0.94 and for LNb = 0.91. A second group of lambs (N=182) was used to validate the BIA formula. High R² for LNa suggested potential product loss, time and labor expenses could be minimized using LNa as dependant variable in validating LNb. LNb predictions had an R² = 0.93 when using LNa as dependant variable. Second group (n=182) was also subjected to live BIA evaluation. BIA is non-invasive, causes minimal discomfort, rapid and equipment is affordable. A BIA prediction formula was developed using Rs, Xc, L and live weight: LNI = 0.973 + 0.3118*live wt) + (0.017*Rs) + (0.1739*Xc) + (0.0102*L) The R² between LNI and LNa (dependant variable) = 0.79. Formulas, LNa, LNb, and LNI were validated on 48 Columbia lambs. Live and carcass predictions, using both anatomical and BIA measures were calculated. Dependant variable was ACT. R² values were 0.82, 0.84 and 0.80 for LNa, LNb and LNI respectively. Data indicate BIA can accurately evaluate weight of LN and has application for both value-based marketing of carcasses and in live animal selection.

Key Words: lamb meat, Bioelectrical impedance, evaluation

1522 Impact of HACCP implementation on the Kansas meat and poultry processing industry. E. Boyle^{*1}, D. Hoffman¹, and M. Schoenbeck², ¹Kansas State University, Manhattan, KS, ²Food Brands, Hutchinson, KS.

Profiles were developed from surveys distributed in 1997 and 2000 to assess the impact of HACCP on federal, state and custom meat and poultry establishments in Kansas. Randomly coded surveys included a cover letter and a stamped, self-addressed return envelope. Reminder postcards were sent one week after surveys were initially mailed. Of 221 surveys sent in 1997, 51.6% responses were received, while a response of 39.1% was received in 2000 from 225 distributed surveys. Nearly 70% of respondents to the 2000 survey responded to the 1997 survey. Overall, inspection status changed for nine plants from 1997 to 2000, 82% of respondents had employees who received some form of HACCP training, 87% of plants had a HACCP program with an average of four HACCP plans per plant, and 60% of respondents spent 45 minutes or less each day filling out, filing or reviewing HACCP paperwork. There was minimal change in the amount or type of product produced as a result of HACCP. Six plant characteristics changed from 1997 to 2000 ($P < 0.05$). Plant managers/owners receiving meat training through an apprenticeship declined from 22% in 1997 to 9.4% in 2000. The use of computers in meat and poultry processing businesses increased from 47.3% to 61.4%. The average year of latest plant renovation moved from 1987 (1997 survey) to 1990 (2000 survey). Nearly three-quarters of respondents had undergone renovations since their facilities were constructed. The last renovation occurred as long ago as 1960 or as recently as 2000. The percent of plants that processed franks decreased from 20% in 1997 to 9.3% in 2000. The use of a phonebook as an advertising medium increased from 42.2% in 1997 to 57.7% in 2000. From 1997 to 2000, the industry changed their emphasis on who they relied on for obtaining meat and poultry information. The use of a government inspector for information declined from 75.9% to 63.3% while consulting university resources increased from 38.9% to 64.6%. Additionally, the use of other

information sources such as the Internet increased from 2.8% to 8.9%. While there have been some changes to the Kansas meat and poultry processing industry as a result of HACCP, the overall impact on the parameters in this survey has been minimal.

Key Words: HACCP, Industry profile, Kansas

1523 Development and Evaluation of an Advanced HACCP Workshop for Meat Processors. Mindy Brashears¹, Dennis Burson¹, Liz Boyle², Fadi Aramouni², Jason Mann¹, and Mark Murphy², ¹University of Nebraska, ²Kansas State University.

A one-day advanced HACCP workshop was developed by Extension Specialists at the University of Nebraska and Kansas State University. The overall goal of this workshop was to increase the knowledge of small meat processing establishments to enable them to more effectively manage HACCP systems in their facilities. Topics discussed in the workshop included; HACCP verification, HACCP validation and experimental design, sampling plans, USDA in-depth verification reviews (IDV), reassessment, auditing, HACCP-based inspection model programs (HIMP), and the relationship of HACCP to total quality management (TQM) programs and statistical process control (SPC). The workshop was delivered as a pilot test program to processors to ensure that the content addressed current needs of the industry. The format for topic delivery was 30 min presentations by Extension Specialists. Additionally, participants completed working group activities that allowed them to design studies to validate or change CCPs in a plan, to apply pathogen modeling programs to specific processes and to subject data collected during HACCP monitoring to SPC in order to identify trends. The participants completed an evaluation after each activity and a focus group analysis was conducted at the end of the workshop. While most participants were familiar with the topics covered, 100% of them indicated that presentations contained information that would be useful in their business. The working group exercises were also helpful to most participants with 60% and 87% of the participants indicating that the HACCP validation case studies and SPC activities would be useful, respectively. Focus group results also indicated that all topics were important to meat processors in the day to day management of their plans. They indicated that on-going HACCP training was important to them and that the advanced topics covered in this workshop should continue to be included in future advanced workshops. They indicated that one-day workshops were a good form of training because they resulted in a relatively small amount of time away from their business and kept them up to date on current issues. Based on these results, the advanced HACCP course will continue to be offered in a similar format delivered to the pilot group.

Key Words: HACCP, Verification, Validation

1524 Development of a Beef Myology and Muscle Profiling Cd-rom. S.J. Jones*¹, C.R. Calikins¹, K.S. Podany¹, D.E. Burson¹, and B.L. Gwartney², ¹University of Nebraska, ²National Cattlemen's Beef Association.

The beef carcass is made up of over one hundred different muscles with different properties that affect processing characteristics and consumer acceptability. Today, the majority of the cuts found in the retail meat counter are boneless, therefore by providing the need for knowledge of the musculature of the beef animal. It is possible to develop a CD-ROM that will serve as a resource for the muscular anatomy of the beef animal. The objective of this project was to develop an electronic manual of the muscular anatomy, and a chemical and physical profile of the 39 muscles located in the chuck and round wholesale cuts. Muscle profiling data were collected in a separate project conducted by Dr Chris Calkins of the University of Nebraska, and Dr. Dwain Johnson of the University of Florida. Additional information on each muscle was collected, including: name, origin, insertion, action, innervation, blood supply, wholesale and retail cut location. Six different sections were developed to view the muscular and skeletal anatomy of the carcass: cross-sections, lateral views, sub-primal views, skeletal views and muscle and bone descriptions by scientific and common name. Using any one of the sections, one can access the data. Visual images were collected by cutting 2.54 cm cross-sections from the side of a 340 kg carcass, producing 86 cross sections. A second side was split into hind and fore quarters, then individual muscles were removed and the carcass portion was photographed. Drawings were developed for each picture, and the

muscles were identified and linked to their respective information. Using Institutional Meat Purchasers Specifications, sub-primal cuts were prepared and photographed every 22.5 degrees to obtain a 360 degree view. A strobe lighting system was used in lighting the cross-sections and lateral layers during photography. Photographs were digitized to JPEG format for use in CD-ROM development. Programming of the CD-ROM was done using HTML language and JAVA script so that the program could be used with a web browser on a computer. Drawings that were made of each cross-section and lateral view were formatted as GIF files and linked to each muscle information file. The Beef Myology and Muscle Profiling CD will be a valuable resource for both industry and academia.

Key Words: Beef, Myology, CD-Rom

1525 Microbial condition of aged lamb meat treated with 1% acetic acid. E.C. Vasconcelos¹, J.F.F Zapata*¹, E.A.T. Figueiredo¹, and M.A.A. Castelo-Branco¹, ¹Universidade Federal do Cear, Fortaleza, CE, Brasil.

Organic acids intended to control microbial contamination on meat surface have been used as 1 to 2% acetic or lactic acid solutions or as a combination of both. The objective of this study was to verify the effect of a single dip in 1% acetic acid solution on microbial condition of lamb meat during aging. Lamb shoulders were collected under commercial practices and cut into meat and bone steaks about 3 cm thick. Steaks were dipped for 1 min in either 1% acetic acid solution or distilled water. Steaks were individually packaged in nylon-polyethylene bags and vacuum-sealed before storing at 1 C. On days 3, 13, 23, 33 and 48 of aging meats were analyzed for mesophilic and psychrophilic bacteria, mold and yeast, total and fecal coliform bacteria, Salmonella and sulfite-reducing Clostridia. Mesophilic and psychrophilic bacterial counts were lower ($p < 0.05$) in meats treated with acetic acid on days 13 and 23 and on days 3 and 13, respectively. Although mold and yeast counts were generally lower in meats treated with acetic acid as compared with the untreated meats this effect was significant ($p < 0.05$) only on days 3 and 13 of aging. On day 3 of aging treated meats were significantly ($p < 0.05$) lower in both total and fecal coliform counts than untreated meats. This difference was not observed with 13, 23, 33 and 48 days of aging although the counts for these types of microorganisms were lower than $1.2 \log \text{cfu g}^{-1}$ in this period. Meat samples were found positive for Salmonella with 3, 13 and 23 days of aging and negative with 33 and 48 days of aging. Sulfite-reducing bacteria were absent in meat samples all through the experimental period. It can be concluded that dipping lamb meat pieces in acetic acid 1% for one minute followed by vacuum packaging and cold storage (1 C) can keep low counts of mesophilic, psychrophilic, and coliform bacteria, as well as mould and yeast for 13 days. During this period, however, Salmonella is not inhibited by the acid treatment.

Key Words: Meat aging, Coliform bacteria, Salmonella

1526 Comparison of recovery methods for freeze-injured Listeria monocytogenes, Salmonella Typhimurium and Campylobacter coli associated with cell suspensions and pork surfaces. V. P. Chang*, E. W. Mills, and C. N. Cutter, Penn State University, University Park, PA 16802.

Freezing, heating, or acidification are known to adversely affect pathogenic microorganisms on meat surfaces, resulting in either death or injury. Injured cells resulting from such treatments may not grow during conventional microbiological procedures due to the presence of compounds or dyes in the media that impair the cell's ability to repair. Therefore, quantification of injured cells is important to ensure overall treatment effectiveness. Recovery of injured cells can be accomplished by combining selective and non-selective media into a single system. With such combinations, the diffusion of the selective compounds or dyes is controlled, allowing for resuscitation of injured cells of interest, while also inhibiting the growth of undesirable background microflora. To date, very little information exists on recovery methods for freeze-injured cells associated with pork surfaces. In this study, Listeria monocytogenes, Salmonella Typhimurium and Campylobacter coli suspended in buffer or associated with pork surfaces were subjected to a freeze-thaw cycle (-15C for 24 h; 4C for 4 h). Following treatments, freeze-injured cells were plated onto media incorporating the following recovery methods: overlay (OV); thin agar layer (TAL); or Lutri plate (LP) method. Media used in this study include: Modified Oxford agar

and trypticase soy agar (TSA) for isolation of *L. monocytogenes*; Xylose Lysine Decarboxylase agar and TSA for isolation of *S. Typhimurium*; Campylobacter blood-free and Brucella agar for isolation of *C. coli*. The recovery rates for the pathogens using the TAL and OV methods following freeze treatments in cell suspensions or on pork surfaces were not statistically different ($P>0.05$) from recovery rates associated with non-selective media. The results presented in this study demonstrate that OV and TAL are reliable and consistent recovery methods for isolation of freeze-injured cells. The TAL method was not only easier to perform, but also allowed for improved isolation of single colonies for further characterization. Further research will utilize the TAL method to determine the effectiveness of blast- and commercial-chilling processes to reduce pathogenic bacteria associated with pork surfaces.

Key Words: Pork, Freeze-injured, Pathogens

1527 Incorporation of nisin into a collagen film retains antimicrobial activity against *Listeria monocytogenes* and *Brochothrix thermosphacta* associated with a ready-to-eat meat product. B. J. Miller* and C. N. Cutter, *Penn State University*.

The foodborne pathogen, *Listeria monocytogenes* (LM) is associated with a variety of ready-to-eat (RTE) meat products. Vacuum packaged, refrigerated meats also may be contaminated with spoilage organisms such as *Brochothrix thermosphacta* (BT). The antimicrobial peptide, nisin, is known to inhibit LM and BT on meats. Nisin is currently approved for use in some foods. In this study, collagen films were soaked in a nisin solution and dried to produce biologically active nisin-incorporated collagen films (NICF). Frankfurters were wrapped with NICF or collagen films without nisin (Control), vacuum packaged, heated (30 min, 100C), cooled, and inoculated with approximately $3 \log_{10}$ CFU/g of LM or BT. Inoculated, NICF and control frankfurters were subjected to refrigerated storage (4C) for up to 14 days or temperature abused (24 h, 25C) and refrigerated (4C) for up to 14 days. Immediately after treatments and following refrigerated storage at days 4, 7, and 14, BT was reduced greater than $1.4 \log_{10}$ CFU/g; whereas LM was not reduced greater than $0.6 \log_{10}$ CFU/g. Following temperature abuse and 14 days of refrigerated storage, BT and LM were reduced by approximately $1 \log_{10}$ CFU/g. This research is the first to demonstrate the incorporation of nisin into a collagen film retains activity against bacteria associated with RTE meat products.

Key Words: Collagen film, Nisin, Ready-to-eat meat

1528 Survival of *Listeria* spp. following bacon processing. L. J. Heffner*, S. L. Flowers, S. L. Hestand, G. L. Kehres, S. Doores, E. W. Mills, and C. N. Cutter, *Penn State University*.

Some meat processors are packaging bacon and RTE meats in the same room. There is concern that because bacon is not a thoroughly cooked product, there is the potential for *Listeria monocytogenes* to survive the curing and smoking process and cross contaminate RTE meats in the packaging room. To address this issue, the individual and combined effects of bacon processing against *Listeria* spp. were reviewed. For the first experiment, pork bellies were inoculated with *Listeria innocua* to obtain approximately $4 \log_{10}$ CFU/g. Inoculated bellies were left untreated (U), injected with sterile distilled water and smoked (liquid smoke and heat treatment to an internal temperature of 53C; IWS), injected with a cure solution (water, sodium phosphate, brown sugar, salt, nitrate, and sodium erythorbate) and smoked (ICS), or injected with cure solution only (IC). Microbiological samples were obtained immediately after treatments (day 0), after 24 hours of refrigerated storage (4C; day 1), and after 9 days of vacuum packaged, refrigerated storage (day 9). Results from the first experiment indicate that immediately following treatments and after vacuum packaged, refrigerated storage, curing alone (IC) does not afford any reductions of *L. innocua*. However, smoking with water or cure (IWS or ICS) reduces the organism greater than $2 \log_{10}$ CFU/g ($>99\%$). Subsequent microwave cooking of the bacon to simulate consumer handling resulted in no detectable growth of *L. innocua*. For the second experiment, pork bellies were inoculated with *Listeria monocytogenes* to obtain approximately $3 \log_{10}$ CFU/g. Inoculated bellies were left untreated (U), injected with sterile distilled water and smoked (IWS), or injected with a cure solution and smoked (ICS). Microbiological samples were obtained immediately after treatments (day 0), after 24 hours of refrigerated storage (4C; day 1), and after 7 days of vacuum packaged, refrigerated storage (day

7). Results from the second experiment indicate that immediately following treatments and after vacuum packaged, refrigerated storage, *L. monocytogenes* was reduced approximately $3 \log_{10}$ CFU/g ($>99.9\%$) to undetectable levels by either the IWS or ICS treatments. This information demonstrates that the bacon process appears to significantly reduce populations of *Listeria* spp.

Key Words: *Listeria* spp., Bacon, Survival

1529 Effects of Electrolyzed Oxidizing Water on Microbial Growth, Lipid Oxidation and Color of Displayed Beef during Refrigerated Storage. Seon-Tea Joo¹, Kumar Venkitanarayanan², and Cameron Faustman², ¹*Gyeongsang National University, Chinju, Korea*, ²*University of Connecticut, Storrs, CT, USA*.

Electrolyzed oxidizing water (EO water) produced by the electrolysis of water containing sodium chloride has been reported to possess strong antimicrobial properties. The major antimicrobial elements in EO water include a low pH of 2.7, an oxidation-reduction potential of $>1,100$ mV, and a free-chlorine level of 10 to 80 ppm. The effects of EO water on microbial growth, lipid oxidation and color of displayed beef during 4°C storage were evaluated. Beef cores (3cm diameter \times 1.5cm thick) from longissimus muscle were prepared, and then dip-treated in distilled water (pH 7.2; control) or EO water (pH 2.5; treatment) for 1, 5 and 10 min at 23°C. Total plate counts, lipid oxidation (TBARS) and color (CIE L*a*b*) were measured at 0, 1, 3, 6 and 9 days of storage at 4 °C. Microbial growth on beef cores was not affected by EO water treatment. The population of all samples was approximately $7 \log$ CFU/cm² after 6 days of display. However, TBARS values of samples subjected to 5 and 10 min of EO water treatment tended to be higher than those of control and 1 min EO water treatment after 6 days. Differences in TBARS between control and 1 min EO water treatment appeared negligible. Samples subjected to EO water treatment showed slightly higher CIE a* values compared to controls, while CIE L* and b* values did not appear to differ among treatments during 9 days of storage. Results were not as conclusive as earlier demonstration of antimicrobial effects of EO water on fruit/vegetables and kitchen cutting boards.

Key Words: Electrolyzed Oxidizing Water, Microbial Growth, Meat safety

1530 Thermal conductivity model for predicting heat penetration in non-stirred raw rendered products. A. K. Greene, C. S. Knight, W. B. Bridges, and P. L. Dawson*, *Clemson University*.

Samples of raw beef, pork and poultry rendered products were collected and analyzed for percent moisture, fat, and bone. The nine mixtures of raw rendering materials were examined in heat penetration studies in a Loveless still retort using a TechniCAL CALPlex 32 Datalogger, Ecklund needle thermocouples, 300x406 two piece steel cans and TechniCAL CALSoft data collection software. Throughout the heating process, a datalogger collected heat data at 10 second intervals and recorded the data on CALSoft software (TechniCal, Inc., New Orleans, LA). All samples were processed to at least a 12D process. The computer software was programmed to use a z value of 18°F (10°C). The computer software recorded accumulated D values and reported length of time to reach a 12D process. Using the collected thermal data, models were created to describe the heat conductivity into each product mixture. The "best fit" non-linear regression model was a logistical function. A logistic function was fit for each replicate of the treatments and compared to the quadratic linear models for each replicate. In all cases, the logistic model produced a much smaller residual or Sum of Squares for Error (SSE) indicating an overall better fit than the quadratic linear model. The logistic model would be recommended for future analysis.

Key Words: Rendering, Thermal process, Food safety

1531 Analyzing Plant Sanitation Processes using Statistical Process Control Techniques. K.J.K Getty* and J.G. Surak, *Clemson University, Clemson, SC*.

Microbiological testing is an effective tool for verifying sanitation programs in meat and poultry operations. The objectives of this study were: 1) to determine if line employees, as represented by university students and employees, not only can clean and sanitize processing equipment but

also can perform microbiological environmental sampling, which evaluates the sanitation process; 2) to develop appropriate microbiological environmental processing specifications (CFU/cm²) for equipment and facility areas; and 3) to determine if data from sampling can be analyzed using statistical process control. A 3M Quick Swab and a 15 X 10 cm template were used to swab facilities and equipment. The swab diluent was poured directly onto one of three 3M petri films (aerobic plate counts (APC); yeast and molds (YM); or *E. coli* and coliforms (EC)). Samples were collected nine times over a seven month period resulting in approximately 35 samples per each film type. The APC counts for the contact meat surfaces prior to cleaning and after cleaning ranged from 0.147 to 2.48 and <0.007 (detectable limit) to 0.25 CFU/cm², respectively, whereas, non-contact surfaces; facility areas; and drains ranged from 0.013 to 0.68; <0.007 to 0.013; 0.153 to 1.78 CFU/cm², respectively. The EC counts for contact surfaces ranged from <0.007 to 0.027. The YM counts for contact surfaces ranged from <0.007 to 0.127 and <0.007 to 0.207 CFU/cm² for yeast and mold, respectively. Data were analyzed using simple statistical process control tools (individual moving range control charts, and capability analysis), thus, allowing the identification of sanitation problems in the plant and development of improvement strategies by students and management. This resulted in decreased counts over time. Companies can utilize microbiological testing procedures and link the results to statistical process control techniques to improve the verification of their sanitation programs.

Key Words: plant sanitation, statistical process control, microbiological testing

1532 Recombinant production of chicken egg-yolk antibodies against Enterotoxigenic *Escherichia coli* by use of a DNA vaccine. S.H. Cho*, P.C. Loewen, and R.R. Marquardt, *University of Manitoba, Winnipeg, MB, Canada, R3T2N2.*

DNA vaccines have been shown to elicit both cellular immunity and humoral immunity in animals. Recent reports have suggested that the administration of vaccines consisting of plasmid DNA may significantly enhance long-lasting antigen specific immune responses. The objective of this study was to investigate the efficacy of DNA vaccines against *Escherichia coli* K88 and K99 in mouse and chicken models. Mice and laying hens were injected with; DNA alone, protein alone, and DNA plus protein then the antibody titres in serum and egg yolk were determined by ELISA. The DNA plus protein injection induced higher and long-lasting antibody titre in both mice and chickens compared to that obtained with DNA or protein alone. Also the antibody titre of DNA plus protein injection after 24 weeks was nearly equal to the maximum values obtained after 8 weeks with either alone. The antibody titre after 40 week was almost 10-fold higher for the DNA plus protein injection compared to that of protein injection alone. The data demonstrates that a DNA vaccine can elicit an antibody response in both mammalian (mice) and avian (chicken) species. It also demonstrates that DNA vaccines injected with their corresponding antigen have the ability to considerably enhance subsequently antibody titre in the blood of mice and the egg-yolk of laying hens. The antibodies produced in the yolk of the chicken against *E. coli* can be used to passively control diarrhoea in young pigs and dairy calves.

Key Words: Egg yolk antibodies, DNA vaccines, Enterotoxigenic *Escherichia coli*

1533 Decreasing cost in processed meat products with the addition of pork collagen. D.R. Doerscher*^{1,2}, G. Prabhu¹, and E. Schoenberg¹, *¹Proliant Inc., ²Iowa State University.*

Pork collagen is a cost-effective, functional ingredient that can improve the quality of various meat products due to its water binding and gel forming capabilities. In many types of meat products, it is not only capable of improving yield, texture and purge, but it can provide cost savings as well. This is especially important from a processor standpoint because it can help improve profitability without sacrificing product quality. Cost savings are achieved by utilizing rehydrated pork collagen to replace more expensive ingredients, such as lean meat or other binders. For example, in a typical reduced fat hotdog formula, the replacement of pork 72's with 1% pork collagen hydrated 1:4 can produce yielded cost savings of approximately 2.5%. Pork collagen also performs well in other comminuted products. In a 97% fat free pork breakfast sausage with the same replacement rate, a savings of 3.8% may be obtained when ham trimmings are substituted. Increasing the usage level to 2% in these systems will also provide cost savings while maintaining product quality. The FDA recognizes pork collagen as a binder and

purge reducing food additive in meat products at usage levels up to 3.5%. However, many meat products have USDA standards limiting the use of binders and added water. Nonetheless, its use is currently permitted in non-standard meat products that permit binders as well as many types of products identified with nutrient content claims. As the use of pork collagen expands, it will be beneficial when maximizing non-meat protein in cooked sausages allowing increased flexibility in maximizing added water. This and other economic advantages of pork collagen will potentially yield high returns to the meat processor.

Key Words: Pork collagen, Cost savings, Processed meats

1534 Evaluation of wet salting in the "Charqui" processing. M. Pinto Neto*¹, H.A. Arima¹, R.O. Villarreal, S.B. Toma, and M.L.Q. Andrade, *¹Instituto de Tecnologia de Alimentos, Campinas, Sao Paulo, Brazil.*

"Charqui", a salted and dried beef product, very popular in Brazil, is usually obtained by wet and dry salting followed by sun drying. This product is stable at ambient temperature and is classified as intermediate moisture food. The wet salting (WS) may be done by injecting or tumbling the meat with a brine. The objective of this study was to evaluate the WS process through tumbling, using a central composite non factorial surface design. Boneless beef flank were tumbled with saturated NaCl brine (26°Baumé). The independent variables tested at two levels plus a central point included proportion brine:meat (PBM) at levels 1:0.5, 1:1 and 1:2, brine temperature (TB) at levels 10, 15 and 20°C, and tumbling time (TT) at levels 20, 30 e 40min. The dependent variables NaCl percentage (Cl%), moisture percentage (W%), water activity (aw), and pH were determined after tumbling. The data were analyzed using the package STATISTICA V.5. The mathematical models obtained were $Cl\% = 5.6581 - 1.4062 * PBM + 0.4237 * TT + 0.2462 * PBM * TT$ and $W\% = 70.2327 - 1.2337 * TB + 1.6687 * PBM$. The analysis of variance (ANOVA) for Cl% indicated that the model was significant at $p < 0.05$, and had a R² value of 0.81. Examination of the fitted coefficients using the F test showed that PBM was significant, while TT and TB were not. The effect of PBM on the Cl%, was inversely proportional. The Cl% in the meat increased varying from 3.5% to 7.0%, as the PBM decreased. There was a positive influence of TT in Cl%, but it was negligible in the range of the experiment. W% had 63.5% (R²0.635) of its variation explained by the regression model which showed no significant lack of fit ($p < 0.05$). TT and PBM had a linear effect on W%, while TB was not significant. The W% in meat decreased from 73% to 67%, as the PBM decreased and TT increased (at fixed TB 15°C). The processing variables PBM, TT and TB did not affect aw and pH.

Key Words: Dried meat, Salting, Charqui

1535 Effect of freezing rate and storage on the functional properties of manufacturing beef. M.M. Farouk*, K.J. Wieliczko, and I. Merts, *AgResearch Ltd.*

A prior study found that freezing rate on its own does not affect the functional properties of thawed muscle proteins. This finding led us to hypothesise that it is the interaction between freezing rate and storage temperature and time that affects protein functionality. The present study was designed to validate this hypothesis. Hot-boned semimembranosus muscles (n = 24) from 12 heifers were held at 10°C until rigor. The muscles were assigned to 24 treatment combinations using an incomplete factorial design with two freezing rates (fast, 12.04 mm/h; slow, 0.56 mm/h) x 3 storage temperatures (-18, -35, -75°C) x 5 storage times (0, 3, 6, 9, 12 months). Functional properties (protein solubility, drip loss, water holding capacity, tenderness, cook loss, emulsion activity index, emulsion stability and colour) were determined. The sulphhydryl content and surface hydrophobicity of the extracted proteins were measured and the changes in soluble sarcoplasmic proteins were determined for each treatment using SDS-PAGE. Storage temperature alone had no effect on the functional properties measured. Rate of freezing alone affected only drip loss, which was higher for the slowly frozen samples. Functional properties were mainly affected by storage time and the interaction between storage time and temperature, confirming our hypothesis. It is concluded that, compared to current commercial practice, very fast freezing and ultra low temperature storage—both very expensive operations—do not improve the functional properties of frozen beef. Thus, from a product quality perspective, capital need not be spent on equipment for faster freezing and ultra low temperature storage of manufacturing meat.

Key Words: Beef, Freezing rate, Functional properties

1536 High temperature conditioning prior to rigor onset does not affect the functional properties of beef subsequently chilled rapidly. M.M. Farouk*, A.E. Graffhuis, and K.J. Wieliczko, *AgResearch Ltd.*

This study attempts to exploit the advantages of high and low rigor temperatures to develop a processing regime that will deliver manufacturing beef of desired functionality. Non-stimulated hot-boned semitendinosus muscles were held at 30°C until rigor onset then were transferred to an immersion chiller at -5°C until the completion of rigor. Meat quality from this regime was compared to that from a standard manufacturing-beef chilling regime (blast freezing of hot-boned boxed beef, 30°C, air velocity 3 m/s) and a very fast chilling regime (packaged hot-boned individual cuts immersed in brine at -5°C). Samples from the three regimes were held at -18°C for one month, then were thawed at -1°C and analysed. Chilling regime did not affect the pH, colour, emulsion activity index, emulsion stability or protein solubility of the thawed meat. All three chilling regimes equally caused muscle shortening (sarcomere length was 1.63 to 1.73 µm) and toughening on cooking (MIRINZ Tenderometer values were 16.2 to 17.4 kgF). Chilling regime did not affect the consumer acceptability of soft jerky or roasts made from the meat. Consumers found the soft jerky to be more acceptable overall than the roasts. It is concluded that the effect of rigor temperature on muscle functionality tends to mask the effects of other factors, that electrical stimulation may have to be used for the purpose of manipulating rigor temperatures to achieve desired functionality in rapidly chilled hot-boned beef, and that cold-shortened meat which is too tough for making roast beef can be used to produce a highly acceptable soft jerky.

Key Words: Beef, Rapid chilling, Functional properties

1537 Influence of beef cuts and cooking time on color properties of a beef sausage model system. J.A. Prez-Alvarez¹, J.M. Fernandez-Gins¹, J. Fernandez-Lpez¹, E. Sayas¹, C. Navarro¹, A. Aznar², and E. Sendra¹, ¹ *Universidad Miguel Hernandez*, ² *Universidad Politcnica de Cartagena*.

The influence of beef cuts (lean, dewlap, chop), and cooking time on color evolution during the cooking process was evaluated in a sausage (mortadella type) model system. Four batches of mortadella type sausage (60 units of 200g. each), were manufactured. Nine color determinations were made in each piece following the recommendations of the American Meat Science Association for color measurements in meat and meat products (CIELAB, 1976 color space). Hue (h*) and chroma (C*) were calculated according to the following formulas $h = \text{atan}(b^*/a^*)$ results expressed in degrees, and $C^* = (a^{*2} + b^{*2})^{1/2}$. Analysis of variance (ANOVA) with two factors (meat composition: two levels 40:40:20; 20:40:40 lean: chops: dewlap respectively and cooking time 15 levels, 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70 minutes), and Tukey's studentized range test were applied to data (P<0.05). The results of this work are presented in the table. Redness and chroma increased during the cooking time, hue (h*) and yellowness (b*) decreased, this last coordinate was not influenced by meat composition. Lightness evolution during cooking time is related to meat composition, and the meaty system (40:40:20) showed the highest lightness and redness.

Cooking time (minutes)	Lightness (L*)	Redness (a*)	Yellowness (b*)	Chroma (C*)	Hue (h*)
0	46.34c	8.86b	13.43f	16.15d	56.88e
5	43.09ab	6.08a	12.10e	13.57b	63.33f
10	40.94a	5.29a	10.59d	11.85a	63.28f
15	41.73ab	5.36a	10.39d	11.71a	62.54f
20	41.54ab	6.37a	9.89cd	11.79a	57.15e
25	42.51ab	8.66b	9.76bcd	13.22b	49.11d
30	42.67ab	10.16c	8.83ab	13.58b	42.05c
35	43.83bc	10.68c	8.73a	14.12bc	41.63c
40	41.76ab	12.27d	8.22a	14.84c	34.24b
45	42.77ab	13.91e	8.50a	16.32d	31.53ab
50	42.85ab	14.71e	9.11abc	17.32d	31.98ab
55	42.40ab	14.91e	8.63a	17.24d	30.15a
60	42.69ab	14.48e	9.01abc	17.08d	31.90ab
65	43.59b	14.37e	8.67a	16.80d	31.14ab
70	43.18ab	14.64e	8.94abc	17.19d	31.53ab
Meat composition					
20:40:40	41.41a	10.44a	9.46b	14.51a	44.35a
40:40:20	44.15b	10.99b	9.85b	15.19b	43.42b

a-c Means within columns with the same letter do not significantly differ (P<0.05)

Key Words: color, beef cuts, cooking time

1538 Antioxidant effect of dried milk mineral in fresh and cooked ground pork. P. Jayasingh* and D.P. Cornforth, *Utah State University, Logan, UT*.

The antioxidant effects of dried milk mineral (MM), butylated hydroxytoluene (BHT) and sodium tripolyphosphate (STP) were compared in fresh and cooked ground pork stored at 2C. In fresh ground pork, BHT (0.01% of fat) and all levels of MM (0.5, 1, 1.5, 2%) were effective antioxidants, with TBA values < 0.1 after 8 days storage at 2C compared to TBA values > 0.4 for control and samples with 0.5% STP. In cooked ground pork, 0.5% STP and 2% MM were excellent antioxidants, with TBA values < 1.0 after 15 days storage, compared to TBA values > 8 for controls and samples with BHT. Thus, MM was an effective antioxidant in both fresh and cooked pork. STP had antioxidant activity in cooked, but not in fresh ground pork. BHT had antioxidant activity only in fresh ground pork.

Key Words: Antioxidant, Milk, Mineral

1539 Effect of rosemary extract, sodium lactate and film permeability on the shelf-life of vacuum packaged ground ostrich meat. A. C. Seydim, Z. B. Gzel-Seydim, I. Y. Han, and P. L. Dawson*, *Clemson University*.

This research studied the effects of oxygen permeability of films, sodium lactate, and rosemary extract on the shelf-life of vacuum packaged ostrich patties. Ground ostrich patties for each treatment were mixed with 0.02% rosemary extract (AO), 3.3% sodium lactate (SL) and mixture of 0.02% AO and 3.3%SL (MIX). Control (NA) samples containing no additive and samples containing additives were vacuum packaged with high oxygen transmission rate (HiOTR) (4000 cc) and low oxygen transmission rate (LoOTR) (3-6 cc) packaging materials. Samples then were stored at 3±1°C in the dark. Two packages for each treatment were selected at 0, 3, 6, and 9 days to use for pH measurement, 2-thiobarbituric acid (TBA) values, color measurements, and microbiological analysis. There was no significant effect of treatments on pH of meat under different oxygen transmission rate packages OTR (P≥0.05). The pH of ostrich patties ranged from 5.97-6.13. In LoOTR packages, no difference was found between TBA values for all treatments (P≥0.05), whereas in HiOTR packages, AO and SL were significantly different (P≤0.05) than NA and MIX. After 9 day of storage TBA value for NA packaged in HiOTR was 1.64 mg malonaldehyde/kg meat. The control sample had a microbial count of 4.3 CFU/g meat initially. In LoOTR packages, microbial populations (total cell count, coliform, *Lactobacilli* and *B. thermosphacta*) were lower than the HiOTR packages for all treatments. Increase in microbial growth for each treatment was observed during storage, whereas their growth were slowed by addition of SL and MIX to ostrich patties. Samples containing SL and MIX had lower microbial populations than AO and NA. SL and MIX treatments provided 2 log reduction in microbial population during storage in both types of package.

L*, a*, b* values were compared before and after opening the packages for both package type. Total color differences (ΔE) were calculated and reflectance differences ($\Delta R_{630-580}$) were determined. LoOTR packages had better color stability as compared to HiOTR packages. AO had significant effect on the a* values before and after opening the packages ($P \leq 0.05$). Reflectance difference data showed that LoOTR packaged ostrich patties did not lose their appealing cherry-red color during the experiment.

Key Words: Ostrich, Rosemary extract, Shelf-life

1540 **Functionality of prerigor meat on the chemical, physical, and textural properties of beef patties.** J.R. Claus*¹, O. Sorheim², and H.-J. Skarpeid², ¹University of Wisconsin-Madison, ²MATFORSK.

The objectives were to determine the effects of prerigor grinding, prerigor salt injection, and time of cooking on the properties of beef patties. Four patty treatments (six replications) tested were: 1) prerigor ground, patties manufactured, and immediately cooked; 2) prerigor ground, salted, stored overnight; 3) prerigor muscle injected with brine, stored overnight; and 4) postrigor ground. Treatments started with semimembranosus (SM) muscles removed (45 min postmortem) from non-electrically stimulated bull carcasses. Lean was ground through a 3-mm plate. Uncooked patties contained 1.7% sodium chloride and 13% fat. On a lean-only meat basis, patties contained 25% water and 6% starch (native). Patties were cooked to 79 C. The pH values of all treatments were different ($P < 0.05$) and decreased from treatment 1 to 4 (6.23 to 5.53 raw patties; 6.28 to 5.81, cooked patties). Cooking losses were lower ($P < 0.05$) for the two prerigor ground treatments (7.6% and 8.6%) than either treatment 3 (12.6%) or treatment 4 (17.9%). Protein solubility in patties from treatment 1 (67.2 mg/g) was higher ($P < 0.05$) than treatment 4 (44.6 mg/g), while treatment 2 and 3 were intermediate. Instrumental cooked patty hardness values were highest ($P < 0.05$) for treatment 2 (8.9 kg peak force), followed by treatment 1 (6.9 kg), treatment 3 (5.0 kg), and treatment 4 (2.7 kg). Patties manufactured from prerigor ground or injected beef were springier ($P < 0.05$) than patties from postrigor ground beef. Prerigor ground patties were more cohesive ($P < 0.05$) than patties from the injected or postrigor beef. Patty chewiness followed the same pattern as determined for hardness. Tomography X-ray scans of injected SM muscles indicated that sodium chloride was not uniformly distributed at the onset of rigor. This may explain the lower pH in comparison to the prerigor ground treatments. The surface of the patties from the prerigor ground beef was lighter and more yellow ($P < 0.05$) than the other treatments. Prerigor beef can be used to manufacture high yielding, firm cooked patties.

Key Words: Beef, Patties, Prerigor

1541 **Postharvest interventions to overcome the tenderness problems in meat from older animals.** M.B. Solomon*¹, B.W. Berry¹, J. Stika², and W.G. Moody², ¹USDA, ARS, FTSL, Beltsville, MD, ²Univ of Kentucky, Lexington, KY.

Previous studies using hydrodynamic pressure processing (HDP) with meat from older animals (cows) have shown no improvements in tenderness. As a result, the assumption was made that HDP affects myofibrillar tissue and not stromal tissue. It was theorized that including a tenderization treatment (e.g., blade tenderization) which might disrupt the intramuscular connective tissue and when combined with HDP might provide successful tenderization of meat from old cows and cuts of meat with excessive connective tissue. Frozen boneless rib (longissimus) muscles (N=4) from ten year old beef cows and two hot boned (<1 hr postslaughter) strip loins, immediately frozen after boning, from one three year old dairy cow were thawed for 48 h at 2 C, then cut into sections. These sections were designated as controls, blade tenderized (BT) only or BT combined with HDP (100 g of explosive @30.5 cm from the meat surface using plastic explosive containers). For the ten year old cows, BT reduced shear force 13% (5.95 vs 5.16 kg), whereas, BT+HDP reduced shear force 21% (5.95 vs 4.71 kg). For the three year old cow, BT reduced shear force 4% (5.38 vs 5.18 kg) while BT+HDP reduced shear force 17% (5.38 vs 4.49 kg). Results suggest that combining BT with HDP may overcome the tenderness problems often encountered with meat from older animals.

Key Words: Cow beef, Tenderness, Postharvest interventions

1542 **Improving tenderness of beef round and sirloin muscles through pre-rigor skeletal separations.** B. C. Shanks*, D. M. Wulf, B. J. Reuter, J. M. Bok, and R. J. Maddock, South Dakota State University.

Thirty crossbred steers were used to explore and compare tenderness improvements in beef round and sirloin muscles resulting from various methods of pre-rigor skeletal separations. Animals were slaughtered according to industry procedures and at 60 min postmortem one of six treatments was applied to each side: **A**) control, **B**) saw pelvis at the sirloin-round junction, **C**) separate the pelvic-femur joint, **D**) saw femur at mid-point, **E**) combination of B and C, and **F**) combination of B and D. After 48-h, the following muscles were excised from each side: semimembranosus (SM), biceps femoris (BF-R), semitendinosus (ST), and adductor (AD) from the round; vastus lateralis (VL) and rectus femoris (RF) from the knuckle; and gluteus medius (GM), biceps femoris (BF-S) and psoas major (PM) from the sirloin. Following a 10-d aging period, samples were removed from each muscle to determine the effect of treatment on sarcomere length and Warner-Bratzler shear force. Most skeletal separation treatments resulted in longer sarcomeres than controls for SM, AD, ST, and GM muscles. All skeletal separation treatments yielded shorter sarcomeres for the PM as compared to controls. Warner-Bratzler shear force differed among treatments for RF, ST and PM. For RF, treatments C, D, E, and F resulted in lower ($P < 0.05$) shear values than for controls. Treatments B, D, and F increased shear force of the ST relative to controls ($P < 0.05$). Treatment F resulted in higher shear force values for the PM than controls ($P < 0.05$). Correlations between sarcomere length and shear force were found to be low and quite variable among muscles. In general, treatments increased sarcomere length of several muscles from the sirloin/round region, but had mixed effects on shear force values.

Key Words: Beef, Skeletal separations, Tenderness

1543 **Relationship of Pork Quality Traits to Consumer Acceptability.** T.K. Ford*¹, R.K. Miller¹, S.J. Moeller², and R.N. Goodwin³, ¹The Texas A&M University, ²The Ohio State University, ³National Pork Producers Council.

To understand the effect of pork lean quality attributes and consumer acceptability, a centrally-located, consumer sensory study was conducted in Boston, Chicago, and Denver. Consumers were served 12 samples of either pork loin chop, inside ham chop, and chicken breast combinations. Pork was obtained from the National Pork Producers Council's Quality Lean Growth Modeling Project so that pork loin and inside ham chops varied in pH, intramuscular fat, and Warner-Bratzler shear force (kg). Chicken breasts were commercially purchased in each city. Consumers rated overall like, juiciness like, tenderness like and flavor like using 5-point, end-anchored hedonic scales. Pork consumer responses were affected by city, cut and, the interaction of city by cut ($P < .01$). In Boston, cuts were rated lower in juiciness, tenderness, flavor, and overall like (3.3, 3.4, 3.3, 3.3, respectively) than consumer ratings in Denver and Chicago (3.5 and 3.5, 3.6 and 3.5, 3.4 and 3.4, 3.4 and 3.3, respectively). Consumers liked ($P < .01$) the juiciness, tenderness, flavor, and overall acceptance of the chicken breasts when compared to the loin chops (3.6, 4.1, 3.6, 3.7 vs. 3.3, 3.3, 3.3, 3.2, respectively). Consumers liked ($P < .01$) the tenderness and overall acceptability of the loin chops compared to the inside ham chops (3.3, 3.2 vs. 3.2, 3.2, respectively), but both chops were rated similarly for juiciness and flavor (3.3, 3.3 vs. 3.3, 3.2, respectively). pH category affected consumer acceptability. As pH increased from the low and medium pH categories to the high pH category, juiciness, tenderness, and overall like increased ($P = .04$, .0165, and .03, respectively). As Warner-Bratzler shear force values decreased, consumer like ratings increased for juiciness, flavor, tenderness, and overall acceptability ($P = .0001$) for loin chops. Lipid category did not affect consumer sensory responses for juiciness, tenderness, flavor, and overall acceptability ($P = .20$, .19, .09, and .18, respectively). As pH increased, consumers liked the juiciness, tenderness, flavor, and overall acceptability of inside ham cuts ($P < .05$). Consumers liked the tenderness of inside ham chops with lower Warner-Bratzler shear force values ($P < .05$).

Key Words: pork, consumer, quality

1544 **Repeatability of Warner-Bratzler shear values in beef steaks using three different cooking methods.** C.R. Kerth*, L.K. Blair-Kerth, and W.R. Jones, Auburn University, Auburn AL.

Instruments used to cook steaks and chops are often inconsistent because of variability in cooking temperatures across the instrument and

from one instrument to the next. Recently research has shown that belt grills are an effective way to cook steaks and chops very rapidly with high repeatability. However, these belt grills are very expensive. The objective of this research was to compare the repeatability of WBS values from steaks that were grilled using a small kitchen clam-shell grill (GRILL), versus AMSA-recommended oven roasting (OVEN), or oven broiling (BROIL) cooking methods. These small, clam-shell grills cook by direct contact with the steaks on both sides, are inexpensive, and are readily available at department and discount stores. To test the effectiveness of these cooking methods, 12 no-roll boneless strip loins were cut into nine 2.5-cm-thick steaks starting from the anterior end. The steaks then were separated into groups of three: the three anterior steaks, the three middle steaks and the three posterior steaks. Each group of steaks was then randomly assigned one of the three cooking methods (OVEN, BROIL, OR GRILL). Steaks were cooked until they reached a final internal temperature of 71°C. Steaks cooked with the BROIL method were turned at 40°C. After cooling to less than 10°C, six 1.3-cm-diameter cores were removed parallel to the length of the muscle fiber and sheared once across the center using a WBS machine. Cooking time for the GRILL method (7.1 min) was shorter, and the OVEN method (22.8 min) was longer compared to the BROIL cooking method (17.5 min, $P < 0.001$). Percent cooking loss was higher ($P < 0.001$) for the BROIL method compared to either OVEN or GRILL cooking methods. However, final cooking temperatures and WBS values did not differ among cooking methods ($P > 0.25$). WBS values across all cooking methods ranged from 1.5 to 7.5 kg. Repeatability of WBS was relatively high for BROIL ($r = 0.83$), GRILL ($r = 0.88$) and OVEN ($r = 0.88$) cooking methods. These data indicate that, in addition to traditional broiling and oven roasting cooking methods, grilling beef loin steaks with an inexpensive clam-shell grill is an acceptable method for cooking steaks for research purposes.

Key Words: Cooking Method, WBS, Clam-shell Grill

1545 Sample location within muscle affects pork quality measurements. E.W. Mills*, S.L. Flowers, and B.M. Moser, Penn State University, University Park PA.

When collecting lean for quality measurements it is customary to take samples from several locations in a muscle cross-section and assume that they represent one population of samples. The purpose of the current work is to test that assumption by evaluating variation in pork quality measurements due to location within a muscle. In the first trial two 25 mm chops were removed from the longissimus thoracis at the tenth rib of 10 market hog carcasses at 24 h postmortem. Twenty-five and 13 mm cylindrical cores were removed near the medial and lateral edges of each chop. Water holding capacity measures were made on the cores - filter paper press method for 0.5g samples from the 13 mm cores and drip loss method for 25 mm cores. Lateral edge samples gave greater ($p < 0.01$) drip loss than medial edge samples after 24 h (5.02 vs. 1.87%) and after 48 h (6.08 vs. 2.63%). Filter paper press results indicated a similar trend in free water % for lateral and medial samples respectively (37.5 vs. 35.7%) but did not indicate a significant difference ($p > 0.30$). In a second trial cores were removed from medial, lateral, ventral and dorsal edges of 25 mm longissimus thoracis chops at 24 hours postmortem for 10 market hogs. In addition to water holding capacity measures as in trial 1, pH, color (L^* , a^* , b^*) and proximate composition were measured. Moisture, protein and fat did not vary significantly ($p > 0.30$) by location. Muscle pH was higher ($p < 0.02$) for medial vs. lateral and dorsal locations with no significant differences among lateral, dorsal and ventral locations. Redness, a^* value, and yellowness, b^* value, were significantly higher ($p < 0.01$) for lateral vs. each other location. Percent free water was highest for lateral and ventral locations but did not differ significantly ($p > 0.30$) among locations (lateral - 35.9%, ventral - 35.9, dorsal - 34.3 and medial - 33.4). Fluid loss after 48 h was greater ($p < 0.05$) for lateral (5.94%) vs. medial (4.52%) or dorsal (4.68%) locations. This work shows that muscle water holding capacity and color vary with location in the cross section of the longissimus thoracis and that drip loss measurement is more sensitive than free water (filter paper press) measurement for assessing meat water holding capacity.

Key Words: Water Holding Capacity, Drip Loss, Color

1546 Heat Penetration Patterns Of Biceps Femoris, Longissimus Lumborum And Semitendinosus Muscles Cooked By Electric Broiler, Electric Belt Grill, Or Forced-Air Convection Oven. E. Obuz, E. J. Yancey, T. E. Lawrence, D. A. King, and M. E. Dikeman, Kansas State University.

The objective of our study was to investigate heat penetration patterns of beef longissimus lumborum, biceps femoris, or semitendinosus muscles cooked by an electric broiler, belt grill, or forced-air convection oven. Subprimals (beef loin, boneless strip loin; beef round, bottom) from USDA Select carcasses were purchased and divided into the respective muscles. Muscles were vacuum packaged and held at 1C for 14 days and then frozen (-37C). Each frozen muscle was sawed into 2.54-cm thick steaks, vacuum packaged, and stored until cooking. Steaks were thawed and held at 4C for 24 h before cooking and were assigned to one of three cooking treatments: an electric belt grill at 163C, a forced-air convection oven at 163C, or an electric broiler (no temperature control). All steaks were cooked to 70C and the center temperature of steaks was monitored using copper-constantan thermocouples. A temperature recorder was used to follow the cooking pattern of steaks and data from the temperature recorder for each steak were retrieved and used to calculate the heat penetration rate for each muscle as min/C. Belt grill cookery gave the highest heat penetration rate for all muscles (three to seven times faster than the other two methods). Within any given temperature range, the semitendinosus required more heat than the other two muscles, which may be explained by its fiber orientation. Up to 40C, heat penetration rate was relatively slow for all muscles. However, heat penetration rate into all muscles decreased above 40C ($p < 0.05$), which likely was because of denaturation of contractile proteins starting at about 40C. The slowest heating rates occurred in the 60-70C interval and can be attributed to collagen shrinkage and protein denaturation. Heat penetration rate between 10 and 20C for the semitendinosus muscle cooked by either forced-air convection oven or electric broiler was almost three times faster than it was between 60 and 70C. Belt grill cookery did not allow us to detect muscle differences in any temperature range because heat transfer was very fast.

Key Words: Heat penetration, electric belt grill, forced-air convection oven

1547 Instruments differ in estimating lightness of fresh meat. C.P. Allison*, R.O. Bates, M.E. Doumit, and A.M. Booren, Michigan State University, East Lansing, MI.

There are many portable instruments available to measure lightness of meat, yet their equivalence is poorly understood. The objective of this study was to determine if differences exist between CIE L^* values determined by three instruments, the Minolta chromameter (M; illuminant D_{65} with a 2° observer), the Hunter Mini-scan spectrophotometer (H; illuminant D_{65} with a 10° observer) and the ColorTec (C; illuminant D_{65}). Color readings were taken on turkey *pectoralis superficialis* (major; $n=80$), pig *gluteus medius* ($n=60$), pig *gluteus accessorius* and *profundus* ($n=60$) muscles. Hunter mini-scan reported twice the variation in L^* values compared to the other two devices (23.13 vs. 12.5 in pig and 6.53 vs. 3.0 in turkey). Due to this heterogeneity of variance, data were normalized to a mean of 0 and a variance of 1. Normalized values were then used for all statistical analyses. The correlations (r) for L^* values of H versus M, M versus C, and H versus C were .90, .82 and .77, respectively and were different from zero ($P < .0001$). However, the r of H with M was higher than the r of M with C and the r of H with C ($P < .01$). The r of M with C was not different from the r of H with C ($P > .05$). We conclude that one instrument should be used to collect data for a given evaluation or experiment, since L^* readings from different devices are not equivalent.

Key Words: Instrument, L^*

1548 Effects of high protein/low carbohydrate swine diets during the final finishing phase on pork muscle quality. J.B. Bok*, D.M. Wulf, B.C. Shanks, B.A. Reuter, and R.J. Maddock, South Dakota State University, Brookings, SD.

The aim of this study was to lower the glycogen stores in pork muscle in order to improve pork muscle quality by feeding an ultra-high protein/low carbohydrate (HIPRO) diet. Fifty barrows (average live weight = 92 kg) were assigned across five treatments and two reps (five pigs per treatment by rep combination). All barrows were fed a control diet

(13.1% CP) until their assigned treatment began. A treatment was the number of days the barrows were fed the HIPRO diet prior to harvest (0, 2, 4, 7, and 14 d). The HIPRO diet (35.9% CP) was 97% extruded soybeans. Daily feed intake and weekly live weights were recorded for all barrows. At-death blood glucose levels were determined. Muscle pH, temperature and electrical impedance were measured in the longissimus lumborum and semimembranosus muscles at 45 min, 3 h and 24 h postmortem. Glycolytic potential, Minolta L*a*b* values, visual scores for color, firmness and marbling, water-holding capacity traits (drip loss, purge loss and cooking loss) and Warner-Bratzler shear force values were determined in the longissimus thoracis et lumborum. Weight gain per day decreased the longer the pigs were fed the HIPRO diet ($P < 0.05$). Daily feed intake decreased during the first week on the HIPRO diet, but returned to near-control levels during the second week, which when coupled with the continued decreases in daily gain, resulted in substantial decreases in feed efficiency during the second week on the HIPRO diet ($P < 0.05$). Blood glucose levels and glycolytic potentials were not lowered by feeding the HIPRO diet ($P > 0.05$); and therefore, no differences in rate of pH decline or ultimate pH among dietary treatments were found ($P > 0.05$). Likewise, there were no differences among dietary treatments in any of the measured meat quality attributes ($P > 0.05$). Feeding barrows the HIPRO diet for a time period prior to slaughter decreased feed intake, rate of gain, and feed efficiency, and was not effective at lowering glycolytic potential or improving pork muscle quality.

Key Words: Pork quality, muscle glycogen, Muscle pH

1549 Effect of supplemental fat on growth, quality, palatability, and fatty acid composition of beef from steers fed barley-potato product finishing diets. D. J. Marks^{*1}, J. R. Busboom¹, M. L. Nelson¹, J. D. Cronrath¹, L. Falen¹, A. E. Koepp¹, and P. S. Kuber¹, ¹Washington State University.

The objective was to evaluate the effects of supplemental fat in finishing diets on feedlot performance, carcass and shelf-life properties, and fatty acid composition of beef. One hundred sixty-eight crossbred steers (318 2.8 kg) were allotted within weight block (3) to a randomized complete block design with a 2 x 3 + 1 factorial arrangement of dietary treatments. Main effects were level of yellow grease (YG; 0, 3, and 6%), and level of alfalfa hay (3.5 and 7%) with the added treatment of 6% tallow and 7% alfalfa hay in barley-based diets containing 15% potato by-product and 7% supplement fed for 165 d. Growth and carcass data were determined on all steers, while longissimus muscle (LM) from four randomly selected animals per pen were used for shelf-life, trained panel and fatty acid analysis. Average daily gain linearly increased ($P < 0.05$) with YG from 1.5 to 1.6 0.16 kg/d and decreased ($P < 0.05$) feed-to-gain from 5.9 to 5.5 0.16. Level of alfalfa hay interacted with YG on backfat, marbling score, beef color score, and percentage choice. Backfat increased with 3.5%, but not 7% alfalfa diets. Marbling was maximized at 3.5% hay, but minimized at 7% hay with the 3% yellow grease diet. There were no effects of diet ($P > 0.1$) on color score, retail purge score, and L*, a* and b* values. Sensory panel initial tenderness scores increased quadratically ($P < 0.10$) with YG from 7.2 to 7.6 to 7.4 0.1, and decreased ($P < 0.10$) with alfalfa level. Diet did not affect total fatty acid (FA) content (DM basis) of LM (143 4.5 mg/g) or fat (958 9.3 mg/g). Level of yellow grease increased CLA quadratically ($P < 0.01$) in LM from 0.45 to 0.64 to 0.62 0.02 g/100g FA and fat from 0.61 to 0.835 to 0.825 0.02 g/100g FA. Yellow grease in the diet increased feedlot performance with no detrimental effects on shelf-life and increased CLA content of beef with no increase in total FA content.

Key Words: Barley, Yellow Grease, CLA

1550 Sensory evaluation of pork longissimus muscle from swine fed soybean meal from Roundup Ready[®] or conventional soybeans. C. L. Armstrong^{*}, W. B. Mikel, and G. L. Cromwell, University of Kentucky, Lexington, KY.

A study was conducted to evaluate the effects of feeding dehulled soybean meal (SBM) from genetically-modified, herbicide-tolerant soybeans containing the CP4 EPSPS protein (Roundup Ready[®] [RR]) or near-isogenic conventional (C) soybeans on sensory ratings, Warner Bratzler Shear (WBS) force, and cook loss of pork longissimus muscle (LM). Soybeans were grown in year 2000 under similar agronomic conditions, the RR soybeans were sprayed with Roundup[®], and both were processed at the same plant. Crossbred pigs (n=100) were fed fortified

corn-soy diets containing C- or RR-SBM from 24 to 111 kg BW. Loins (n=30) were obtained from 15 barrows/treatment (three replications of five pigs/replication). Fresh LM samples were removed at 24 h post-mortem and frozen until analysis for sensory and chemical traits. Three (2.54 cm thick) chops were cooked on a Farberware grill to an internal temperature of 71 C. An experienced sensory panel evaluated each chop for juiciness, tenderness, off flavor, flavor intensity, connective tissue and overall acceptance on a scale from 1 to 8, with 8 being the most desirable. Weights were recorded before and after cooking to determine cook loss. Three 1.26 cm cores were taken from each of the two remaining cooked chops for WBS force determination. Chemical analysis showed percentage of fat between chops from the two treatments tended to be slightly higher for the RR-SBM group (3.10 vs 2.74). Sensory analysis revealed that the C-SBM versus RR-SBM treatment groups were not different ($P > 0.05$) in juiciness (5.52 vs 5.58), tenderness (5.91 vs 6.10), off flavor (7.08 vs 7.18), flavor intensity (5.74 vs 5.95), connective tissue (6.54 vs 6.53) or overall acceptance (5.80 vs 6.05). Also, WBS force values (3.95 vs 3.58, kg) and cook loss (31.97 vs 30.28, %) were not different ($P > 0.05$) between the two treatment groups. Thus, these results indicate that type of soybean meal in feed had no effect on product quality.

Key Words: Pork, Sensory, Biotechnology

1551 Assessing Real Time Augmentation of USDA Yield Grade Application to Beef Carcasses Using Video Image Analysis (VIA) Instrumentation. R. Steiner^{*1}, A.M. Wyle², K.E. Belk¹, J.A. Scanga¹, J.W. Wise³, J.D. Tatum¹, and G.C. Smith¹, ¹Colorado State University, Fort Collins, CO/ USA, ²Research Management Systems, Fort Collins, CO/ USA, ³USDA AMS Branch, Washington, DC/ USA.

ABSTRACTword This study assessed the ability of two video image analysis (VIA) instruments, VIAscanTM and Canadian Vision System (CVSTM), to augment the assignment of USDA Yield Grades (YG) to beef carcasses, to the nearest tenth of a grade, under commercial operating conditions, and to test the accuracy of cutability predictions. Steer and heifer carcass sides (n = 290) were selected to vary in fatness, muscling and weight. Carcasses were assigned augmented YG (AYG), to the nearest tenth (i.e., YG 1.3, 2.6, 4.9), on an automated grading chain (360 head/hour) by each of the two VIA systems, and subsequently fabricated into closely-trimmed (.6 cm) subprimal cuts. Augmented YG that included line graders' estimates for adjusted PYG, and VIA measured ribeye area were highly correlated (r = .92 and .95 for VIAscanTM and CVSTM, respectively) with Gold Standard YG (committee of experts, at their leisure). Cutability prediction accuracy increased to levels near those achieved by expert whole YG, where VIAscanTM AYG, CVSTM AYG and expert whole YG accounted for 59, 60, and 62 percent of the variation in fabricated yields of closely-trimmed subprimal cuts, respectively. Video Image Analysis technology for use in the augmentation of USDA YG appears to be a useful tool for increasing the accuracy and objectivity of USDA YG application, as well as for improving the accuracy of prediction of subprimal yields. Augmentation of USDA YG through use of VIA instrumentation improves USDA line graders YG assignment accuracy. Assigning USDA YG to the nearest tenth would provide substantial economic benefit to the beef industry, allowing fabrication styles and inventories to be more closely managed. VIA instrumentation is a viable augmentation option for use by USDA line graders in assigning YG to the nearest tenth.

Key Words: Subprimal, Yield, Augmentation, Video Image Analysis

1552 Ozonation of animal wastewater to reduce environmental impact. J. K. Duke^{*}, L. W. Grimes, G. C. Skelley, and A. K. Greene, Clemson University.

Samples of wastewater from a confined animal feeding operation (CAFO) and a slaughter facility were ozonated and analyzed for reduction in biochemical oxygen demand (BOD₅), chemical oxygen demand (COD), coliform bacterial content, and aerobic bacterial content. Samples from the swine farm were collected from the flush pit of a 125 head swine-feeding floor. Subsamples were collected after 0.0, 0.5, and 1.0 hr of laboratory ozonation. At the cattle packing plant (500 head per day), samples were collected from the harvest floor and from the anaerobic lagoon discharge. After transport to the laboratory, samples were ozonated for 0.0, 0.25, 0.5, 0.75, and 1.0 hr. Ten-milliliter subsamples

were collected for analysis at each time interval. BOD₅ and COD determinations indicated reductions across all times on all samples. Coliform and aerobic bacterial content were measured using 3M Petrifilm[®]. Results indicated significant reduction ($P < 0.05$) in mean bacterial plate counts of 1 to 3 log for all samples over all times for both coliform and aerobic plate determinations.

Key Words: Wastewater, Ozonation, Environment

1553 Reducing airborne bacteria and molds using a germicidal air cleaning system. C.J. Cundith*, C.R. Kerth, W.R. Jones, T.A. McCaskey, and D.L. Kuhlers, *Auburn University, Auburn AL.*

The objectives of this study were to determine the effectiveness of a germicidal air cleaning system on the reduction of airborne molds and bacteria in a controlled environment and in a meat processing plant. Components of the cleaning unit were tested to determine their individual effectiveness. The UV light alone was capable of a 4.99 log reduction in Gram-positive bacteria (*Micrococcus luteus*) and a 5.76 log reduction in Gram-negative bacteria (*Serratia marcescens*). The filter alone, filter and electrically polarized, low-density media combined and the filter, electrically polarized, low-density media and UV light combined reduced ($P < 0.05$) *M. luteus* (84.0, 90.9, and 92.3% respectively) and *S. marcescens* (84.1, 87.3, and 90.2% respectively). The cleaning units were also examined for their effectiveness in reducing indigenous airborne bacteria and molds from ambient air in production conditions. Two types of cleaning units were used, a duct-mounted unit and wall-mounted console units. Testing was done at 3, 6, 9 and 24 hours after the duct-mount units were activated. The duct-mounted cleaning units reduced ($P < 0.05$) airborne molds by 66.8% in the heating, air conditioning and ventilation unit, and were found to be effective ($P < 0.05$) within 3 hours after activation. The console wall mounted units were tested under controlled conditions in the meat carcass chill cooler, processing room and carcass aging cooler using 1, 2, 3 or 4 cleaning units. Using 2, 3 or 4 units reduced ($P < 0.05$) airborne bacteria and molds. The console units then were tested in the processing room for their effectiveness in reducing airborne bacteria and molds in production conditions. Three and four cleaning units reduced airborne bacteria (21.6 to 61.4%) and molds (20.3 to 63.2%) during production in the processing room. Without the cleaning units in the processing room, both bacteria and mold counts increased ($P < 0.05$) from day 1 to day 4. These data indicate that germicidal air cleaning units containing UV light, filter, and low-density polarizing media are effective in reducing airborne bacteria and molds in a meat processing environment.

Key Words: Airborne, Bacteria, Mold

1554 Development of decontamination procedures for beef trimmings. C. S. Ebeling*, R. K. Miller, and G. R. Acuff, *Dept. Animal Sci., Texas A&M University, College Station, TX.*

Escherichia coli O157:H7 has become recognized as an important food-borne pathogen, with undercooked ground beef identified as the most frequent outbreak cause. Beef trimmings present a challenge to the meat industry due to a higher degree of bacterial contamination occurring in ground beef than in whole-muscle products because of extensive handling procedures during production. Interventions are needed to reduce microbiological levels on beef trimmings. Beef trimmings of 73/27 or 50/50 lean and fat content were obtained from a commercial plant. Trimmings were randomly assigned to four treatments: control, 4% lactic acid (LA), 4% lactic acid plus hot water (LA+HW), and 4% lactic acid plus 10% trisodium phosphate plus hot water (LA+TSP+HW). Meat color was evaluated on both trimming types before and after treatment and on ground beef chubs on days 0, 7, 14, 21, and 28 of storage. The L*, a*, and b* color space values were determined to measure objective color, and trained color panel was used to measure subjective color. After treatment, the lean color of all trimming types was darker ($P < 0.01$) or grayer ($P < 0.01$) in the LA+HW or LA+TSP+HW treated trimmings. Lean color of the ground beef was not noticeably darker ($P < 0.05$) due to treatment after grinding, but the LA treatment resulted in visually darker ($P < 0.01$) ground beef especially with subsequent storage time. A trained descriptive attribute panel evaluated flavor quality characteristics of the ground beef patties on each storage day. The LA treated patties had slightly lower levels of cooked beef/brothy ($P < 0.01$), cooked beef fat ($P < 0.01$), and grainy ($P <$

0.01) flavors. Total aerobic plate counts (APC) were measured on excised sample after treatment and on ground samples on each storage day. The LA+HW and LA+TSP+HW treatments reduced surface APC of trimmings by $1 \log_{10}$ CFU/cm². However, treating beef trimming with LA reduced the APCs of the ground beef by $1.3 \log_{10}$ CFU/g and lowered ($P < 0.01$) APCs on days 7, 14, and 21 compared to control and other treatments. These treatments, especially LA+HW would be an acceptable intervention step to be further examined to assist in decontamination of beef trimmings without adversely effecting shelf-life and flavor attributes.

Key Words: beef, decontamination

1555 Processing and product development of goat meat products: fermented cabrito snack stick and cabrito smoked sausage. G.H. Cosenza*, S.K. Williams, D.D. Johnson, and C. Sims, *University of Florida, Gainesville, FL.*

The production of high quality, value added goat meat products could increase the consumption, acceptability and marketability of goat meat. The objectives of this study were to develop a fermented cabrito snack stick and a cabrito smoked sausage containing different levels of soy protein concentrate in an effort to reduce their final product costs; conduct consumer acceptance, proximate analysis, pH, water activity and smoke-house yields and losses to evaluate and ensure quality and acceptance of these goat meat products; and to perform a comparative cost analysis to determine cost benefit of using soy protein concentrate in formulation of fermented cabrito snack stick and cabrito smoked sausage products. The levels of soy protein concentrate used to replace the goat meat were 0%, 1.75% and 3.50%. The trained panelists detected no significant "soy" off-flavor differences ($P > 0.05$) between the three formulation levels of soy protein concentrate for the fermented cabrito snack stick and cabrito smoked sausage. The consumer panelists detected no significant differences ($P > 0.05$) in the flavor, texture and overall acceptance attributes for the fermented cabrito snack sticks, and the cabrito smoked sausage products formulated with 0% and 3.50% soy protein concentrate. The fermented cabrito snack sticks formulated with 3.50% soy protein concentrate had a lower ($P < 0.05$) fat content than the 0% level. The fermented cabrito snack sticks formulated with 0% soy protein concentrate had the highest price of \$1.31, and the 3.50% level had the lowest price of \$1.25 per 42.61g serving size. There were no differences ($P > 0.05$) in moisture, fat and protein for the cabrito smoked sausage formulated with 0% and 3.50% soy protein concentrate. The addition of soy protein concentrate resulted in a \$1.30 per kg reduction in the price of the cabrito smoked sausage formulated with 3.50% soy protein concentrate (i.e., cost was \$13.49 per kg), when compared to the sausage formulated with 0% soy protein concentrate (i.e., cost was \$14.79 per kg). This project will enhance the marketability of goat meat and provide new and successful markets for Florida's goat industry.

Key Words: Goat Meat, Fermented Cabrito Snack Stick, Cabrito Smoked Sausage

1556 Use of sodium citrate to enhance tenderness and palatability of pre-rigor beef muscles. C. D. Perversi*¹, C. R. Calkins¹, and J. Velazco², ¹*University of Nebraska-Lincoln*, ²*Instituto Tecnológico de Estudios Superiores de Monterrey, Monterrey, Mexico.*

Previous research demonstrated glycolytic inhibition enhanced beef tenderness, despite causing substantial contraction by injection and tumbling of pre-rigor muscles. This project was designed to evaluate the effects of pre-rigor treatment with sodium citrate on the tenderness and palatability of beef muscles from the thoracic limb; the muscles were injected while maintaining skeletal restraints to contraction. Thoracic limbs from 14 steers were removed within 2 hr post-mortem and pumped to 10% of muscle weight with water, 200 mM, or 400 mM sodium citrate solutions. Controls remained on the carcass during chilling. Steaks (2.54 cm thick) were removed after 24 hours from the *Infraspinatus*, *Supraspinatus*, and *Triceps brachii* muscles and were either frozen immediately or aged for 6 more days. A consumer panel evaluated palatability (juiciness, tenderness, connective tissue amount, and flavor desirability) on *Infraspinatus* and *Triceps brachii* steaks using 9-point hedonic scales. Warner-Bratzler shear force values on 1.27 cm-diameter cores were determined on all muscles. Treatment with 400 mM sodium citrate improved shear force values over the control in all three muscles (3.32 vs. 3.61 kg and 2.79 vs. 3.50 kg for d1 and d 7 *Infraspinatus*

[$P < .10$]; 3.55 vs. 3.71 kg and 3.09 vs. 3.59 kg for d1 and d7 *Triceps brachii* [$P < .10$]; 4.19 vs. 5.30 kg and 4.03 vs. 4.78 kg for d1 and d7 *Supraspinatus* [$P < .05$], respectively). Tenderness ratings followed the same trend as shear force values. Flavor desirability ratings of beef treated with 200 or 400 mM sodium citrate were equal or superior control muscles. These data indicate that sodium citrate may be applied to pre-rigor beef muscles (constrained from contraction) to enhance tenderness and palatability.

Key Words: Beef, Tenderness, Palatability

1557 Mapping intramuscular tenderness variation in four major muscles of the beef round. B. J. Reuter*, D. M. Wulf, B. C. Shanks, J. M. Bok, and R. J. Maddock, *South Dakota State University, Brookings, SD.*

The objective of this project was to quantify intramuscular tenderness variation within four muscles from the beef round: biceps femoris (BF), semitendinosus (ST), semimembranosus (SM), and adductor (AD). At 48 h postmortem, the BF, ST, SM, and AD were dissected from either the left or right side of ten carcasses, vacuum packaged, and aged for an additional 8 d. Each muscle was then frozen and cut into 2.54-cm-thick steaks perpendicular to the long axis of the muscle. Steaks were broiled on electric broilers to an internal temperature of 71 C. Location-specific cores were obtained from each cooked steak and Warner-Bratzler shear force was evaluated. Definable intramuscular tenderness variation (SD = 0.56 kg) was almost twice as large as between-animal tenderness variation (SD = 0.29 kg) and 2.8 times as large as between-muscle variation (SD = 0.20 kg). The ranking of muscles from greatest to least definable intramuscular tenderness variation was BF, SM, ST, and AD (SD = 1.09, 0.72, 0.29, and 0.15 kg, respectively). The BF had its lowest shear force values at the origin (sirloin end), intermediate shear force values at the insertion, and its highest shear force values in a middle region 7 to 10 cm posterior the sirloin-round break point ($P < 0.05$). The BF had lower shear force values towards the ST side than towards the vastus lateralis side ($P < 0.05$). The ST had its lowest shear force values in a 10 cm region in the middle, and its highest shear force values towards each end ($P < 0.05$). The SM had its lowest shear force values in the first 10 cm from the ischial end (origin), and its highest shear force values in a 13 cm region at the insertion end ($P < 0.05$). Generally, shear force was lower towards the superficial (medial) side than towards the deep side of the SM ($P < 0.05$). There were no intramuscular differences in shear force values within the AD ($P < 0.05$). These data indicate that definable intramuscular tenderness variation is substantial and could be used to develop alternative fabrication and (or) merchandising methods for beef round muscles.

Key Words: Beef, Intramuscular, Tenderness

1558 Chemical characterization of beef inside and outside semimembranosus for improved color stability. LM Sammel*¹, MC Hunt¹, and DH Kropf¹, ¹*Kansas State University.*

The color instability of the beef semimembranosus (SM) has been troublesome to the meat industry and continues to be problematic in modified atmosphere packaging. The deep or inside portion of the SM (ISM) is lighter in color and discolors faster than the superficial or outside SM (OSM). The relationships of 5 assays for metmyoglobin reducing ability with color stability were determined at 5 and 14-days of storage. Combinations of cold or hot boning with and without electrical stimulation were used to create different postmortem declines in temperature and pH for the ISM and OSM to examine effects on chemical characteristics and initial color and stability. Aerobic reducing ability and reduction of nitric oxide metmyoglobin showed less activity in the ISM than OSM, and in tissue stored 14 compared to 5 days. The assay for total reducing activity and reduction of dichlorophenolindophenol showed more activity in muscles stored 5 compared to 14 days but showed few differences between the muscle portions. Reductions of horse and bovine metmyoglobins were inconsistent between muscle portions and storage times. Aerobic reducing ability correlated best with visual panel scores and metmyoglobin accumulation in the SM. Cold-boned ISM had a slower chill rate; faster pH decline; more denatured protein; less metmyoglobin reducing ability, oxygen consumption, and water-holding capacity; and a lighter, less stable color than the OSM. Cold-boned steaks were two-toned in color and discolored by day 3 of display. Hot-boned ISM and OSM chilled at the same rate and had similar pH declines, similar chemical characteristics, and acceptable color traits up to day 5 of display.

Myoglobin concentration, heme iron, nonheme iron, and lipid oxidation did not explain differences in color stability between the ISM and OSM. Methods that chill the ISM more rapidly should produce a more uniform, stable color by conserving reducing ability and protein integrity. Extending the color life of the ISM should reduce the need for reworking and discounting after only 2 days of retail display.

Key Words: Semimembranosus, Metmyoglobin, Color Stability

1559 Effects of cold shortening and cooking rate on tenderness, postmortem proteolysis, and cooking traits of beef longissimus and triceps brachii muscles. D.A. King*¹, M.E. Dikeman¹, T.L. Wheeler², C.L. Kastner¹, and M. Koochmariaie², ¹*Kansas State University, Manhattan, KS,* ²*Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE.*

Our study evaluated the effects of cold shortening and cooking rate on postmortem proteolysis, tenderness, and cooking traits of beef longissimus thoracis (LT) and triceps brachii, long head (TB) muscles. The LT and TB were removed at 45 min (left side) and 24 h (right side) postmortem from 12 carcasses and trimmed of fat. Muscles removed at 45 min were placed in an ice bath to induce cold shortening. At 24 h postmortem, muscles were cut into 2.54 cm steaks and assigned to aging (1 or 14d) and RAW and cooking (FAST or SLOW) treatments. Steaks were cooked at 260° C (FAST) or 93° C (SLOW). Cooking loss (CL), cooking time (CT), and Warner-Bratzler shear force (WBSF) were measured for cooked steaks. Sarcomere length (SL) and the extent of proteolysis of desmin were measured on all steaks. Rapid chilling resulted in shorter ($P \leq .05$) SL. TB steaks had longer ($P \leq .05$) SL than LD steaks. RAW steaks had longer ($P \leq .05$) SL than cooked steaks regardless of shortening. FAST cooking resulted in shorter ($P \leq .05$) SL than SLOW cooking in normal steaks, but cooking rate had no effect on shortened steaks. Generally, TB steaks required longer ($P \leq .05$) CT and had higher ($P \leq .05$) CL than LT steaks, and FAST cooked steaks had greater ($P \leq .05$) CL than SLOW cooked steaks. Shortened steaks had less ($P \leq .05$) degradation of desmin than normal steaks (31 vs. 41%, respectively). Aging for 14d increased ($P \leq .05$) desmin degradation. Cold shortening resulted in much higher ($P \leq .05$) and aging resulted in lower ($P \leq .05$) WBSF values. SLOW cooked TB steaks were more tender ($P \leq .05$) than FAST cooked TB and FAST and SLOW cooked LT steaks. These data indicate that shortened muscles undergo proteolysis, but at a slower rate than normal muscles. Cooking rate did not affect tenderness of LT steaks, but SLOW cooking resulted in lower WBSF values for TB muscles, presumably because of collagen solubilization.

Key Words: Beef Tenderness, Proteolysis, Cooking

1560 Relationships between mechanical tenderness measurements and trained sensory panel attributes of beef Longissimus lumborum muscle. T. S. Hively*¹, R. K. Miller¹, D. S. Hale¹, D. K. Lunt², T. L. Wheeler³, and M. Koochmariaie³, ¹*Dept. Animal Sci., Texas A&M University, College Station, TX,* ²*Texas Agriculture Experiment Station, McGregor, TX,* ³*Roman L. Hruska U. S. Meat Animal Research Center, Clay Center, NE.*

Mechanical assessment of beef tenderness is widely used. Varying methods have been reported in the scientific literature: Warner-Bratzler shear force (WB), Allo-Kramer shear force (AK), and slice shear force (SS). In addition, trained meat descriptive attribute sensory evaluation of myofibrillar tenderness (MT), connective tissue amount (CT) and overall tenderness (OT) are used to evaluate tenderness of beef. The objective of this research was to understand the relationships between these mechanical measures of tenderness and trained meat descriptive attribute sensory panel ratings of beef tenderness. Beef steers ($n = 63$) varying in live animal characteristics to induce variation in tenderness were slaughtered, electrically stimulated, and two strip loins (IMPS -180) were removed 48 h postmortem. Loins were subsequently vacuum-packaged, aged 14 d at 5C and then cut into 2.54 cm thick steaks. Within each animal, steaks were randomly assigned to one of four treatments: WB, AK, SS or trained sensory evaluation of MT, CT and OT using 8-point scales (1 = extremely tough, abundant and extremely tough; 8 = extremely tender, none, extremely tender, respectively). Steaks varied in tenderness across mechanical and sensory measures (2.4 to 7.4 kg for WB, 8.1 to 27.8 kg for AK, 7.0 to 42.4 kg for SS, 3.7 to 7.6 for MF, 4.7 to 7.9 for CT and 3.7 to 7.6 for OT). Mean measures for tenderness were 4.1 kg for WB, 13.6 kg for AK, 15.7 kg for SS, 6.3 for MT, 7.0 for CT and 6.3 for OT. The OT and WB values were correlated at -0.70 (P

< 0.01) whereas OT and AK were correlated at -0.61 ($P < 0.01$) and OT and SS at -0.70 ($P < 0.0001$). Respective correlation coefficients between MT and WB, AK and SS were -0.70, -0.59 and -0.60; while simple correlation coefficients between CT and WB, AK and SS were -0.66, -0.60 and -0.51, respectively. As expected, correlation coefficients among sensory measures were high (> 0.9 , $P < 0.01$). These data indicate that the common mechanical measurements of beef tenderness are highly correlated to each other and they are highly correlated to trained sensory measures of beef tenderness, although the apparent lower correlation between SS and OT as compare to WB and AK may be due to differences in cooking method (belt grill vs. electric grill).

Key Words: beef, shear force, tenderness

1561 Quality evaluation of case-ready beef steaks from various USDA grades. J. M. Behrends^{*1}, W. B. Mikel¹, C. L. Armstrong¹, Y. L. Xiong¹, and S. Harris², ¹University of Kentucky, ²Cryovac/Sealed Air Corporation.

Introduction of case-ready fresh meats to the marketplace has demonstrated a need to evaluate the benefits of this technology. The objectives of this study were to evaluate visual and chemical attributes of three different USDA quality grades (High Choice and above, Low Choice, Select) and three different muscles (semimembranosus, semitendinosus, and biceps femoris) of beef steaks encased in high-oxygen (80% O₂/20% CO₂) modified atmosphere packaging (MAP). Steaks from each treatment group (3 muscles, 3 grades, 2 packaging types) were displayed under retail conditions for 1, 3, 5, 7, and 10 d. Three steaks from each muscle-grade-package type combination were evaluated on each day by a five-member trained panel for visual color (lean color, discoloration, overall acceptability) and analyzed with a Minolta Chroma Meter CR-300 for L* a* b* values (lightness, redness, yellowness). Chemical analysis included percent metmyoglobin and lipid oxidation (TBARS). There were no grade x packaging interactions ($P > 0.05$) for lean color, discoloration, overall appearance, or L*, a* and b* values. However, the main effect of grades for these quality parameters was significant, with Low Choice and Select being higher than High Choice for L* values and Low Choice being more desirable than both High Choice and Select for lean color, discoloration, overall appearance, and a* and b* values. There were no grade x packaging interactions for percent metmyoglobin and TBARS values, however, grade had a main effect ($P < 0.05$) on percent metmyoglobin content, with High Choice being higher than both Low Choice and Select. TBARS values also differed ($P < 0.05$) among grades. These findings indicate quality grade has a major influence on color stability of high-oxygen packaged beef steaks. Regardless of muscle type and grade, however, whole muscle steaks from the round can achieve an extended shelf-life by use of novel MAP technology.

Key Words: Case-ready, Quality, Oxidation

1562 Diverse birth and rearing housing systems: effects on pig growth, meat quality and muscle fiber types. J. G. Gentry^{*}, J. R. Blanton, Jr., J. J. McGlone, and M. F. Miller, Texas Tech University, Lubbock.

The objective of this experiment was to examine the effects of diverse birth and rearing environments on pig growth, meat quality and muscle fiber types. Barrows (n=48, 6 pigs/pen) were randomly selected from a group of indoor-born and outdoor-born pigs at weaning and placed into an indoor or outdoor growing/finishing environment. The outdoor environment consisted of 4 pens (212 m²/pig) on alfalfa pasture. The 4 indoor pens (1.2 m²/pig) had concrete slatted flooring. Pigs were slaughtered at an average weight of 114 kg at a commercial facility. Fiber type samples were taken from the *longissimus* (LD) and *semimembranosus* (SM) muscles at 4 hr postmortem and stored at -80°C until analysis. Samples (12-m thick) were stained histochemically with ATPase after acid pre-incubation (pH= 4.3) to detect I, IIA and IIB fiber types. Boneless loins were collected following 24 hr chilling and aged for 14 d. Chops (2.54 cm thick) were cut for sensory and shear force analysis. Data were analyzed using the GLM procedures of SAS (1995) with pen as the experimental unit. Outdoor-born pigs grew faster than indoor-born pigs (ADG, kg/d: .81 vs .72 .03, $P < .05$). Outdoor reared pigs had more backfat, higher NPPC color scores and lower CIE L* values than the indoor reared pigs ($P < .05$). Sensory panel scores for pork flavor intensity were 6.07 and 6.48 .10 for the indoor and outdoor-born groups, respectively ($P < .05$). Shear force values were lower for the group finished outdoors (2.0 vs 2.2 kg .06, $P < .05$). LD and SM from

the outdoor reared group had a lower percentage of type IIB fibers (LD: 66.6% vs 73.2% 2.0, SM: 53.6% vs 65.1% 3.1; $P < .05$). Type I fibers in the SM represented 13.8% and 24.6% 3.1 for the indoor and outdoor reared pigs, respectively ($P < .05$). Outdoor rearing of pigs may improve pig growth, pork color and tenderness. Further studies should be conducted to link pork quality measures with muscle fiber types and environmental housing systems.

Key Words: Pigs, Housing systems, Pork quality

1563 Goat kids meat quality: artificial rearing and weight at slaughter effects. A. Arguello^{*1}, A. Marichal¹, J.F. Capote², and J.L. Lopez¹, ¹Animal Production Unit, Las Palmas de Gran Canaria University, Arucas, Spain., ²ICIA, La Laguna, Spain..

The objective of our study was to examine the effects of the rearing system and weight at slaughter on meat quality in young Canary Caprine Group kids. Forty twin, male kids were allotted to one of four groups based on feeding regimens: kids nursed by their dams (ND, n: 10), or kids fed a commercial milk replacer (23.7 percent CP and 22.8 percent fat) and controlled intake (CR, n: 10), and live weight at slaughter: 6 kg (WS6, n: 10), or 10 kg (WS10, n: 10). Immediately after slaughter, pH was measured on the Longissimus dorsi (LD). The carcasses were chilled at 4 C for 24 h, and pH, Warner-Brazler shear force (WBSF), color (Lightness, L, Chroma, C, Hue, H), water holding capacity (WHC), chemical composition (moisture, protein, fat, ash, collagen and his solubility), muscle fiber types proportions and their areas, were determined in the LD muscle. No interactions were observed in any parameter between rearing method and weight at slaughter. No statistic effect were founded in pH values, although the ND kids showed a higher pH values when the weight at slaughter increased, the evolution in CR kids were opposite. Compared with the WS10 kids, the LD muscle from WS6 kids had higher L ($P < .05$), but no differences were founded in Chroma or Hue. Rearing method and weight at slaughter did not affect to WBSF, but a relation between WBSF and solubility collagen may be observed. The meat from ND animals were more exudative than CR kids ($P < .001$), while no statistic effect was observed by weight at slaughter. The chemical composition changed lightly, reducing moisture percentage ($P < .001$) and increasing protein proportion ($P < .001$) in WS10, probably due to hypertrophy growth muscle fiber areas were higher. No effects were described in muscle fiber type population. The WS10 muscle fiber area was higher than WS6 ($P < .05$), but in opposite the rearing system did not show statistic effects. Thus, the results show that using milk replacers in goat kids and increasing the weight at slaughter did not affect negatively to meat quality.

Key Words: Kid meat quality, Rearing system, Weight at slaughter

1564 Comparison of breed and diet on factors associated with tenderness in two muscles. P. S. Kuber^{*1}, J. R. Busboom¹, S. K. Duckett², D. J. Marks¹, P. S. Mir³, Z. Mir³, R. G. McCormick⁴, C. T. Gaskins¹, J. D. Cronrath¹, and M. V. Dodson¹, ¹Washington State University, Pullman, WA, ²University of Idaho, Moscow, ID, ³Agriculture and Agri-food Canada, Lethbridge, AB, ⁴University of Wyoming, Laramie, WY.

The objective of this study was to evaluate attributes associated with tenderness in divergent breeds, Wagyu (**W n=12**), Limousin (**L n=12**) and F1-cross cattle (**WxL n=12**), fed two dietary treatments (either 0 or 6% sunflower oil). Data were analyzed using GLM procedures with breed and diet as main effects in a 2 x 3 factorial arrangement of treatments. Cattle were fed a barley-based diet for an average period of 259 d. Twenty-four hours post mortem (**PM**), steaks from the *longissimus* (**LD**) and *semitendinosus* (**ST**) were sliced, vacuum packed, aged (1, 3, 7, 14, 28 and 56 d **PM**) at 2°C and frozen (-40°C) until analyzed. Breed differences in Warner-Bratzler shear force (**WBS**) existed ($P < 0.05$) across aging times in LD. A WBS breed x day interaction existed in ST ($P < 0.05$) and tended to exist in LD ($P = .11$). On d 14, W LD ($P < 0.05$) required 0.77 kg less force to shear than L. Comparatively, W were more desirable in d 14 LD sensory panel sustained tenderness ($P < 0.05$) than L. In the ST, WxL ($P < 0.1$) required 0.60 kg less force to shear than L, but no difference ($P > 0.1$) in ST panel initial or sustained tenderness was evident. Wagyu LD and ST samples were slower ($P < 0.05$) in pH decline, and more rapid ($P < 0.05$) in temperature decline than L or WxL. Breed and diet did not affect ($P > 0.1$) free calcium (**FC**) over time (0, 1, 3, 7 and 14 d **PM**), 0 h calpastatin activity (**CA**), d 1 % collagen (**OH-Pro**), or d 1 collagen cross-linking (**HP**) in LD;

or d 1 OH-Pro and d 1 HP in ST. Western blot analysis for measuring the presence of the Troponin-T (Tn-T) 30kda fragment demonstrated more proteolysis in LD at d 3 in L than W or WxL. Breed differences in mechanical and sensory measures of tenderness existed (d 14 - LD and ST), but were not explained by FC, CA, OH-Pro, HP and Tn-T.

Key Words: Wagyu, Limousin, Beef Tenderness

1565 *In-vitro* oxidation of bovine oxymyoglobin as affected by 4-hydroxy-nonenal. A.L. Phillips*, S. Lee, L.K. Silbart, and C. Faustman, *University of Connecticut, Storrs, CT.*

Discoloration from the desirable cherry red to brown color in fresh meat is a result of oxidation of ferrous oxymyoglobin (OxyMb) to ferric metmyoglobin (MetMb). Lipid oxidation, among other factors, influences the rate of fresh meat discoloration. 4-Hydroxy-nonenal (HNE), a known product of ω -6 fatty acid oxidation, is very reactive toward protein and has been shown to accelerate equine cardiac OxyMb oxidation. Our objective was to determine the influence of HNE upon bovine skeletal OxyMb *in-vitro* under a variety of temperature (4, 25 and 37°C) and pH (5.6 and 7.4) conditions and to identify the adduction of HNE to OxyMb using Western Blots. Bovine skeletal muscle myoglobin (Mb) was purified from beef via ammonium sulfate fractionation and gel filtration

chromatography. OxyMb was prepared by hydrosulfite-mediated reduction and adjusted to physiologic or post-mortem pH via phosphate (pH 7.4) or citrate (pH 5.6) buffer dialysis, respectively. OxyMb (0.15 mM) was incubated with 1 mM HNE (OxyMb:HNE) at 4, 25 and 37°C; controls were aldehyde-free. Following incubation, samples were passed over a desalting column to remove unreacted HNE, scanned spectrophotometrically from 650 to 450 nm, and the percentage of MetMb calculated. Western Blot analysis was completed using control and OxyMb:HNE reacted at pH 7.4, 37°C for 2 hr. Identification of Mb bound HNE was visualized using a monoclonal antibody specific for HNE bound to histidine residues. Overall, MetMb formation increased with increasing temperatures and was greater at pH 5.6 than pH 7.4 ($P \leq 0.05$). At 37°C, a prooxidant effect of HNE was seen at pH 7.4 but not at pH 5.6 when compared to control ($P \leq 0.05$). At both 25 and 4°C, a prooxidant effect of HNE was seen at pH 7.4 and 5.6 relative to CON ($P \leq 0.05$). Western Blots revealed that OxyMb:HNE incubated at pH 7.4, 37°C yielded OxyMb:HNE adducts at histidine residues whereas control samples showed no reaction. This research suggests that HNE accelerates *in-vitro* bovine skeletal muscle OxyMb oxidation and appears to do so, in part, via covalent modification at histidine residues.

Key Words: 4-hydroxy-nonenal, Oxymyoglobin, Metmyoglobin

ADSA Dairy Foods: Products, Processing, Chemistry, Sensory

1566 Rheological Characterization of Butter Oil Obtained from Yogurt and Milk. Sevim Kaya* and Ahmet Kaya, *Gaziantep University.*

Butter oil, clarified butter or anhydrous milk fat is a widely consumed food product in southeast of Turkey. The aims of the study were to investigate and compare the rheological characters of butter oil from yogurt and milk using flow curve and oscillation frequency sweep tests at various temperatures. The steady shear flow data of the butter oil samples were investigated using a rheometer HAAKE RheoStress RS1 with a cone and plate system (d:35 mm, $\alpha :2^\circ$) and in combination with a Peltier/Plate TCP/P temperature control unit at temperature range of $35-70 \pm 0.05^\circ\text{C}$. Data were analyzed using a RheoWin Data Manager. The measurements were repeated three times, each time using a fresh sample and the average values were used to analyze data. Newtonian behavior was observed for the samples ($r^2 \geq 0.998$) at the temperature range studied. Increasing temperature decreased the viscosity. Activation energies of butter oil from yogurt and milk were 21.7 and 21.6 ± 0.2 kJ/mol, respectively showing that there was no difference between samples produced using different methods above the temperature 35°C . In addition to the temperature range studied above, another temperature range ($35-29 \pm 0.05^\circ\text{C}$) was studied to observe the structural conditions of the samples analyzed using an oscillation frequency sweep test. It was found that at low frequencies the viscous behavior reflected by loss modulus is dominant whereas at high frequencies the elastic behavior reflected by storage modulus is outweighing. This shows solid like behavior of samples at higher frequencies. When the log crossover point was plotted versus temperature, below 35°C samples made from yogurt and milk showed different characteristics due to different fatty acid composition of the samples.

Key Words: Butter oil, yogurt, rheology

1567 Acceptance of camel milk among elementary school students in Al Ain, UAE. Isameldin Hashim*, *United Arab Emirates University.*

Milk is an important food for children. Although camel is the dominant animal in the U.A.E., camel milk is not available commercially. The objectives of the study were to investigate: 1) consumption of milk and dairy products among elementary school students, 2) hedonic rating for sensory characteristics and overall acceptance of camel milk, and 3) acceptability of flavored camel milk. A questionnaire was designed to provide information on milk and dairy products consumption, milk flavor preference and willingness to participate on a milk tasting test. The questionnaire was distributed to 470 students (boys and girls, grades 4, 5 and 6) at elementary schools (public and private) in Al Ain. A panel of 173 students was selected to evaluate the milk samples (fresh cow milk, dried cow milk, fresh camel milk and chocolate-flavored camel milk). Seven-point hedonic scale (smiling faces) was used for rating the

color, aroma, taste, texture, and overall acceptance of the milk. Most of the students (93.2%) drink milk and only few (9.6%) drink camel milk. Most of the participants drink chocolate (43%) and strawberry-flavored (38.3%) milk. Beside the milk most of the participants consume other dairy products (yogurt, liquid yogurt, chesses and ice-cream). Camel milk had the lowest ratings for taste (3.2), aroma (4.1), and overall acceptance (3.8) compared to the fresh and dried cow milk (5.3 - 5.9). However, flavoring camel milk with chocolate enhanced the attributes of camel milk specially the taste (6.4), aroma (6.3) and overall acceptance (6.2).

Key Words: camel milk, acceptance, elementary school, UAE

1568 Effect of formulation and processing on emulsion stability of recombined sterilized milk. G. Prez-Hernandez, S. Bhatia, and R. L. Richter, *Texas A&M University, College Station, TX.*

The objectives were to determine the effect of product formulation and processing conditions on the composition of the milk fat globule membrane in recombined sterilized milk and to determine the effect of these changes on the emulsion stability. Samples contained casein to whey protein ratios of 80:20, 60:40, 40:60 and 0:100, and 0.5% monoglycerides, 0.5% lecithin, or a mixture of lecithin with monoglycerides. The protein and fat concentrations of the milk were 3%. Samples were homogenized at 20 and 90 MPa and sterilized at 121°C for 15 min. Emulsions were characterized by stability index, protein load, particle size distribution, and rheological parameters. Inclusion of monoglycerides in the samples caused the mean pH for all samples to decrease from 6.58 to 6.56 ($p \leq 0.0152$). Maximum viscosity occurred in samples with a casein to whey protein ratio of 0:100. This was caused by denaturation of whey protein during sterilization. There was a four fold increase in volume surface average diameter as the ratio of whey protein in the samples was increased from 80:20 ($0.4425\mu\text{m}$) to 0:100 ($1.7175\mu\text{m}$). The surface area of particles in all treatment increased as the homogenization pressure increased. Particle surface area increased when samples that had a casein to whey protein ratio of 0:100 were formulated with emulsifier. Emulsifiers did not affect the particle surface area in any other sample. The protein load increased as the ratio of whey protein in the samples increased. Inclusion of emulsifiers in the samples caused the protein load to decrease. Stability index increased as viscosity, particle surface area and relative distribution width increased and pH and protein load decreased.

Key Words: emulsion stability, recombined milk, sterilization

1569 Commercial whey protein concentrates: protein aggregation profile study. Samira Roufik*¹, Michel Britten², and Paul Paquin¹, ¹Centre de recherche en sciences et technologie du lait (STELA), Université Laval, Québec/Canada, ²Centre de recherche et de développement sur les aliments (CRDA), St-Hyacinthe, Québec/Canada.

Commercial whey protein concentrates (WPCs) exhibit different functional properties even when they have nearly the same total protein content. The aim of this study was to investigate the WPCs protein aggregation profiles to see if we can explain their functional variability through differences in their aggregated state. High performance size exclusion chromatography (HPSEC) technique using a TSK Gel[®] G-4000 PW XL column was performed to study the protein aggregation profiles of seven commercial WPCs. Results show for all WPCs under study the presence of two protein fractions, the aggregated protein fraction (APF) and the native protein fraction (NPF). The WPCs apparent APF proportion varies between 9.83% and 29.21% which reflect their variable level of aggregation. By performing centrifugation at 48 000 g during 45 min (25°C), we have separated these two protein fractions. Then, using HPSEC technique with a TSK Gel[®] G-3000 PW XL column we have characterized the NPF while the APF was characterized with electrophoretic techniques.

Key Words: Whey protein concentrates, Aggregation profile, Protein fractions

1570 Effect of drying methods on functional properties of tarhana, a wheat flour-yogurt mixture. Mehmet Hayta*¹, Mehmet Alpaslan¹, and Ahmet Baysar², ¹Inonu University, Department of Food Engineering, ²Inonu University, Department of Chemical Engineering.

Tarhana is a traditional product prepared by mixing wheat flour, yogurt, yeast and spices followed by fermentation for several days and drying after fermentation. The information on functional and sensory properties is essential for process design, quality control and consumer acceptability. In this study, the changes in functional and sensory properties of tarhana as affected by different drying methods were investigated. Tunnel-dried (TD) tarhana had significantly ($P < 0.05$) higher foaming capacity compared to freeze-dried (FD), home microwave oven-dried (HMD) and industrial microwave-dried (IMD) samples. FD tarhana had the highest protein solubility value ($P < 0.05$) and was followed by TD, IMD and HMD samples, respectively. All tarhana samples exhibited pseudoplastic behavior as apparent viscosity-rotational speed data fitted to a power law model. A significant ($P < 0.05$) decrease in oil absorption capacity was observed for TD tarhana compared to other drying methods. Water absorption capacity of each tarhana sample was significantly ($P < 0.005$) different. On the basis of soluble protein content, TD tarhana had the highest emulsion activity value. No significant differences were observed in odor and mouth-feel among the drying methods used. However, flavor of FD tarhana gruel was significantly ($p < 0.05$) different from other samples. IMD tarhana gruel had the highest overall rating and was followed by TD, HMD and FD, respectively. The lightness (L) value of FD sample was the highest and the HMD sample had the lowest L value. The L values for HMD and IMD samples were smaller than TD and FD samples. In contrast, b value was found to be higher for HMD and IMD samples.

Key Words: Tarhana, functional properties, sensory properties

1571 Effect of freezing process on the microstructure and stability of stabilized ice cream-type systems. K. Montoya and H. D. Goff*, University of Guelph, ON, Canada.

Ice cream model systems without fat and in the presence and absence of locust bean gum (LBG) and guar gum were frozen quiescently and in a scraped-surface freezer (dynamic freezing) with both low and high overrun. Samples were temperature cycled from -10 to -20°C for 15 and 50 cycles. Cryo-Scanning Electron Microscopy (Cryo-SEM) techniques and image analysis were used to determine structure and ice crystal size distributions. Results showed that microstructure of the two systems was different; dynamic samples showed discrete, block shaped crystals without connectivity and randomly dispersed in a system comprised of a continuous serum phase and air cells whereas quiescent samples showed a more continuous ice phase with irregularities on a dendritic type of crystal, or elongated crystals closely packed and separated just by the

serum. Stabilizers did not affect the initial size and distribution of ice crystals in either system. After temperature cycles, ice recrystallization occurred in the order of LBG < guar gum < no stabilizer only in quiescently frozen systems. For dynamic samples lower recrystallization rates were found compared to those of quiescent. In dynamic systems stabilizers did not exert a significant effect ($p < 0.05$) in retarding ice recrystallization, although there was a trend towards lower recrystallization in LBG samples with low overrun ($p < 0.10$). The mechanisms by which polysaccharide stabilizer may control ice recrystallization may have been affected by the freezing process. LBG effectiveness has been attributed to the formation of a gel matrix around the ice crystals enhanced by LBG-milk protein phase separation. The presence of shear during freezing in the scraped surface heat exchanger may have disrupted this microstructure. This provides further insight into stabilizer functionality and suggests caution in extrapolating the results from one process to the other.

Key Words: Ice cream, Polysaccharide stabilizer, Scanning electron microscopy

1572 Effect of Incubation Temperature and Homogenization on the Rheological Properties of Set Yogurt During Gelation Process. S.A. Ibrahim*¹, R.R. Shaker², B. Abu-Jdayil², and R.Y. Jumah², ¹North Carolina Agricultural and Technical State University, Greensboro, NC., ²Jordan University of Science and Technology, Irbid, Jordan..

Fresh raw milk was standardized (3% fat) and split into 2 portions. One portion was heated at 90°C for 3 min using a plate heat exchanger and homogenized at 13.79 Mpa. The second portion was heated at 90°C for 3 minutes without homogenization. Each portion was divided into 3 parts (450 ml each), inoculated with 3% yogurt starter culture (Joghurt 2 Type MK consisting of *Streptococcus thermophilus* and *Lactobacillus delbrückii sub. bulgaricus*) and incubated at 40, 45, and 48°C, respectively to determine the effect of incubation temperature and homogenization on the rheological properties of set yogurt during the gelation process using a cylindrical rotational viscometer. The optimum incubation temperature for acid development was observed at 45°C. The minimum viscosity was observed at 40°C while the maximum viscosity was at 48°C. The results indicated that incubation temperature affected yogurt viscosity during the gelation process while homogenization had no significant effect. The power law model was used to describe the flow behavior of set yogurt. Increasing the incubation temperature decreased the flow behavior index and increases the consistency coefficient. Homogenization increased the flow behavior index and decreased the consistency coefficient.

Key Words: Yogurt, Rheological properties, Homogenization

1573 The Effect of Salep and Locust Bean Gum Concentration on the Rheological Characteristics of a Turkish-type Ice-cream Mix. Sevim Kaya*¹, ¹Gaziantep University.

A traditional Turkish type ice cream is prepared from whole milk, sugar and salep. Salep, a natural polysaccharide, is used as a stabilizer. The effect of salep and locust bean gum concentration (0.2, 0.4, 0.78 and 1.00 g per 100 mL) on the flow behavior of the ice-cream mix has been investigated over a range of shear rates. The temperature dependency of the flow behavior of the mixes was also studied obtaining data at four different temperatures. The steady shear flow data of the ice-cream mixes were investigated using a rheometer HAAKE RheoStress RS1 with a cone and plate system (d:35 mm, $\alpha : 2^\circ$) and in combination with a Peltier/Plate TCP/P temperature control unit at temperature range of 5-30 $\pm 0.05^\circ\text{C}$. Data were analyzed using a RheoWin Data Manager and SigmaPlot for Windows. The measurements were repeated three times, each time using a fresh sample and the average values were used to analyze data. The empirical power law was observed to fit the shear stress-shear rate data ($r \leq 0.998$). Increasing stabilizer concentration decreased the power law index values which were in the range of 1.00-0.30 and 0.79-0.53 for 0.2-1.0 g salep per 100 mL mix and 0.2-0.78 g locust bean gum per 100 mL mix at 5°C, respectively. A gradual increase in salep concentration was found to alter the rheological characteristics of the mix from Newtonian to non-Newtonian. It was found that there was not any significant difference between apparent viscosity values of ice cream mixes containing 1 g of salep per 100 mL or 0.4 g locust bean gum per 100 mL ($p \leq 0.05$). The temperature-dependency of the

apparent viscosities of the samples with different salep and locust bean gum concentrations was also determined. It was observed that temperature effect were not significant on the apparent viscosity values of each concentration studied ($p \leq 0.05$) except 0.2 and 0.4 g per 100 mL salep concentration.

Key Words: salep, rheology, ice-cream

1574 Effect of double homogenization and whey protein concentrate on the texture of ice cream. P. R. Ruger*¹, R. J. Baer¹, and K. M. Kasperon¹, ¹*Dairy Science Department, South Dakota State University, Brookings, SD, USA.*

Ice cream was made with a mix composition of 11% milk fat, 11% milk solids-non-fat (MSNF), 13% sucrose, 3% corn syrup solids (36 dextrose equivalent), 0.28% stabilizer blend or 0.1% emulsifier and vanilla extract. Mixes were HTST pasteurized at 80°C for 35 s, homogenized at 141 kg/cm²-35 kg/cm² (2000 psi-500 psi), and cooled to 3°C. Six treatments were prepared from 4 batches of mix. Mix from batch one consisted of 0.1% emulsifier. Half of this batch, treatment 1 (T1), was cooled to 3°C and the other half, upon exiting the pasteurizer, was heated to 60°C, rehomogenized at 141 kg/cm²-35 kg/cm² (T2), and cooled to 3°C. Mix from batch two consisted of 0.28% stabilizer blend. Half of this batch was used as the control (T3), the other half, upon exiting the pasteurizer, was heated to 60°C, rehomogenized at 141 kg/cm²-35 kg/cm² (T4) and cooled to 3°C. Batch three consisted of 0.1% emulsifier and 1% whey protein concentrate (WPC) substituted for 1% MSNF. It was heated to 60°C, rehomogenized at 141 kg/cm²-35 kg/cm² (T5), and cooled to 3°C. Batch four consisted of 0.28% stabilizer blend and 1% WPC substituted for 1% MSNF. It was heated to 60°C, rehomogenized at 141 kg/cm²-35 kg/cm² (T6), and cooled to 3°C. Results showed no difference ($P > 0.05$) in mean ice crystal size between T3, T4, and T6, however T4 and T6 had a smaller mean ice crystal size than T1, T2, and T5. Mix viscosities were tested one day after manufacture. The viscosity of T3 was greater ($P < 0.05$) than all other treatments and the viscosities of T4 and T6 were greater than T1, T2, and T5. Milk fat and total solids of all treatment mixes were similar ($P > 0.05$).

Key Words: Ice cream, Homogenization, Whey protein concentrate

1575 Lack of effect of a specially designed yogurt for the eradication of *Helicobacter pylori* infection. L. Ozimek*¹, C. Wendakoon¹, S. Appelman², and A. Thomson², ¹*Department of Agricultural, Food & Nutritional Sc.*, ²*Division of Gastroenterology, University of Alberta.*

Helicobacter pylori infection is associated with an increased risk for the development of duodenal and gastric ulcers, chronic active gastritis, MALToma and gastric cancer. Various consensus guidelines have been developed to recommend when it is appropriate to test for and treat the presence of *H. pylori*. Standard treatment usually involves triple therapy with one two week course of antibiotics plus proton pump inhibitor. This regimen is approximately 85% effective, yet it is expensive, difficult to take and may be associated with the risk of development of diarrhea and enteric infection. Probiotics have been suggested as a possible therapeutic agent, and a specially designed yogurt derived from three strains of lactobacillus has been shown to be of a comparable inhibitory effect of *H. pylori* *in vitro* as compared with standard concentrations of amoxicillin and clarithromycin. Because the *in vitro* sensitivity of *H. pylori* may not necessarily predict its *in vivo* effect, we undertook an open study with 27 asymptomatic post-menopausal women positive for *H. pylori* on gastric biopsy, and administered 250 cc of yogurt three times a day for one month. Then, one month later, a ¹³C-urea breath test (UBT) was administered. In all 26 of 27 patients the UBT remained positive one month after a course of yogurt. In summary, the *in vitro* anti-*Helicobacter* effect of a mixture of specially designed yogurt does not predict the *in vivo* eradication of the infection.

Key Words: *Helicobacter pylori*, Probiotics, *In vitro* & *in vivo* studies

1576 Determination of B₁₂, biotin, and folic acid in infant formula by Biomolecular Interactive Assay. Thom Grace*¹, Deliang Cai², and Mingrui Guo², ¹*Biocore Inc. 384 Sam Webb Rd. Fairfax, VT. 05454.*, ²*Dept. of Nutrition and Food Sciences, University of Vermont, Burlington, VT 05405.*

The current methodologies for water soluble vitamin analysis are generally manipulative, and imprecise or insensitive. In this study, the precision and accuracy of the BIACORE Q system of biomolecular interaction analysis for the quantitative determination of B₁₂, biotin and folic acid in infant formula were evaluated. Two types (soy-based and milk-based) of commercial powdered infant formula were used for the analyses. Fifteen separate samples were prepared for each formula type and run singularly for reproducibility analysis. A single sample was also analyzed in replicates of 16 for the reproducibility of the instrument. The values of coefficient of variation (CV) for B₁₂, biotin, and folic acid were 6.2, 5.6, and 3.7%, respectively. Recovery test was also carried out by spiking with each vitamin at four different concentrations across each assay range of detection. The recovery rates were ranging from 96 to 105% for all the three assays. The results of this study show that the Biocore biomolecular interactive technology may be a good alternative for quantification of the water soluble vitamins, to the traditional methods

Key Words: Biomolecular interactive assay, infant formula, water soluble vitamin

1577 Microbial content and distribution in Turkish kefir grains. Z. B. Guzel-Seydim*, A. C. Seydim, J. T. Wyffels, and A. K. Greene, *Clemson University, Clemson, SC, USA.*

Kefir is a fermented dairy product made by addition of kefir grains into milk. In kefir grains, lactic acid bacteria and yeast symbiotically live in a slimy polysaccharide matrix known as kefiran. The objectives of this study were to determine the microbial content of grains and to observe the microbial distribution in Turkish kefir grains using scanning electron microscopy. Kefir grains had a ratio of 10⁶ cfu/g yeast to 10⁹ cfu/g lactic acid. Scanning electron microscopy indicated yeast colonization on the surface and middle of the kefir grain. Short, long and curved lactobacilli were throughout the grain. Lactococci were not observed under SEM; preparation of kefir grains for SEM may have caused removal of lactococci from the grains if they were lightly bound to the grains.

Key Words: kefir, fermented dairy products, scanning electron microscopy (SEM)

1578 Comparison of component interactions and mineral distribution in infant formulas prepared with organic or inorganic mineral salts. Casey R. Smith*¹, Mingrui Guo¹, Gregory M. Hendricks², and Robert S. Tyzbir¹, ¹*Dept. Nutrition and Food Sciences, University of Vermont.*, ²*Medical School, University of Massachusetts.*

Poor bioavailability of essential trace elements, such as copper, iron, and zinc, in commercial infant formula may be related to their low solubility, which may be affected by the forms of added mineral salts. Substituting organic for inorganic mineral salts may increase solubility and availability of minerals in infant formula. Ten 2.5 kg paired batches of whey-protein dominated liquid infant formula (40:60 casein to whey protein ratio) were processed in our university laboratory, with either organic or inorganic salts of Cu, Fe, and Zn. Organic formula (OF) and inorganic formula (IF) were heated to 55C, 60C, 65C, 70C, or 75C immediately preceding homogenization. Nitrogen (N) and mineral distribution were determined by measuring the contents of N and selected minerals in the fat, serum, and pellet fractions obtained on centrifuging the formula at 45,000Xg for 2 hours at 4C. Mineral levels were evaluated by inductively coupled plasma atomic emission spectroscopy, and nitrogen content was determined by the macro-Kjeldahl method. There were no notable differences in mineral and nitrogen distribution between unheated OF and IF. However, pre-homogenization heat treatment (PHT) seemed to have an impact on both nitrogen and mineral distributions in the experimental formulas. The level of iron in the serum was higher for OF at a PHT of 55C with 58.93% of total Fe in the serum fraction, compared to IF which was highest at 60C with a maximum of 49.64%. There was no significant difference detected in the percentage of copper in the serum fraction between OF and IF. Serum Zn was significantly higher ($p < .05$) in OF than IF (38.52% vs 30.65%) at PHT 55C. Percentage of N in the

serum fraction of both OF and IF was highest at a PHT of 60C. Total solids (TS), protein, and ash in the formulas were also analyzed. OF averaged slightly higher TS at 11.75%, whereas IF averaged 11.66%. Ash content in IF (0.33%) was slightly higher than that of OF (0.32%). The microstructures of both formulas were also examined. According to our results, organic mineral salts of Fe and Zn may be substituted for inorganic salts of Fe and Zn to enhance mineral solubility in infant formula, however, further research is needed to elucidate and verify methods to increase trace mineral solubility.

Key Words: Infant formula, component interaction, mineral distribution

1579 The effect of human milk pasteurization on the growth of Bifidobacteria. Luciana M. Borba¹, Celia L. L. F. Ferreira*¹, Sylvia C. Franceschini¹, and Tania Toledo¹, ¹Federal University of Viosa.

There is an increasing recognition of the importance of human milk banks. In such institutions, the donated milk is pasteurized to increase its safety. However little is known about the effect of heated milk upon the desirable microbiota of the newborn. In this work, pools of human milk (same age of maturity) were analyzed through addition of 4 different strains of Bifidobacteria, human origin. Isolates from *Bifidobacterium bifidum* (*B. bifidum*) ATCC 29521, *B. breve* ATCC 15700, *B. longum* ATCC 15707, and a newly isolate *B. breve* AJ 32 were inoculated in a whole pasteurized human milk (WPHM), and WPHM plus pasteurized human milk filtrate (35%) and plus unpasteurized human milk filtrate (35%). After a 24 hours incubation at 37°C, under anaerobic conditions, the contents of each treatment were plated in TPY agar (SCARDOVI, 1986), counted and compared with the counts of the initial time of incubation (time0). The difference between time 24 and 0, gives the degree of the stimulation or inhibition of the heated/unheated milk. The log average of the three repetitions of the CFU/mL of this difference were: -0,28/-0,18/+0,33 for ATCC 29521; -0,30/-0,26/+0,12 for ATCC 15700; -0,18/-0,22/+0,10 for ATCC 15707; and #0,25/-0,26/+0,17 for AJ 32, in the WPHM; WPHM + pasteurized filtrate; and WPHM + unpasteurized filtrate, in that order. The addition of the unpasteurized milk filtrate in the base (pasteurized) stimulate the growth of the 4 strains evaluated here in, and the difference of this treatment was statistically significant (p<0,05). This results indicate that the addition of Bifidobacteria of human origin to the pasteurized milk in the human banks could be beneficial to the newborn.

Key Words: Human milk, Pasteurization, Bifidobacteria

1580 Lactobacillus acidophilus translocation in rats feeding cholesterol rich diet. Dayse F. Machado¹, Celia L. L. F. Ferreira*¹, Neuza M. B. Costa¹, Lorena M. Ybarra¹, Eveline M. C. Azevedo¹, and Maria R. G. Cond¹, ¹Federal University of Viosa.

Probiotics are known as functional foods and individuals consuming a rich cholesterol diet are prone to consume such products. This work was devised to verify the effect of a cholesterol rich diet in translocation - the passage of microorganisms from intestinal environment to other organs and tissues, and rate of "clearing" of *Lactobacillus acidophilus* NCFM. One hundred and sixty weaned Wistar rats, divided in 4 groups and caged individually were used. The diets administered were: (1) standard (AIN-93G, "ad libitum"); (2) control (AIN-93G plus cholesterol and cholic acid); (3) control plus 0,1ml/day of Reconstituted Skimmed Milk (RSM) at 10%; (4) control plus 0,1ml/day of acidophilus concentrate at levels of 10¹⁰ CFU/ml, for 14 days. Translocation was evaluated in heart, kidney, liver and spleen of all animals at 0 and 28 days after the end of probiotic administration, through the screening for total count in MRS agar. Translocation was observed in all organs of group 4, but not in the others. The average translocation (\pm standard deviation) were 35(\pm 3,49)/ 16(\pm 2,28); 45(\pm 2,62)/ 27 (\pm 2,51); 26 (\pm 3,28)/ 11 (\pm 1,84); 68 (\pm 2,52)/ 22 (\pm 2,96) CFU/g from heart, kidney, liver and spleen, respectively at 0 and 28 days. The time required for the complete elimination of *Lactobacillus* from the organs was calculated according to adjusted regression models and corresponded to 48, 68, 48 and 41 days for heart, kidney, liver and spleen, respectively. Results from previous studies with rats receiving standard diet with RSM or *L. acidophilus* at the same levels and periods, showed initial average translocation number higher than in this work however the clearing time was shorter - 28, 26, 28 and 32 days. The current data indicated that cholesterol rich diet could increase the clearing rate of probiotic microorganisms. Since the implication of microbial translocation in the host is not known

especially in those with different degrees of debility, the translocation capacity and the rate of clearing are suggested to be important parameters for the selection of strains to be used as probiotics.

Key Words: *Lactobacillus acidophilus*, Translocation, Cholesterol diet

1581 A comparative study of the microstructure of caseins in dried milk products. B. S. Oommen*¹, D. J. McMahon¹, and W. R. McManus¹, ¹Utah State University.

Microstructure of caseins in non-fat dried milk, calcium caseinate, sodium caseinate, and calcium caseinate formed from acid casein dissolved using calcium hydroxide were studied using transmission electron microscopy. Solutions of all the dried products were made to a casein concentration of 2.4% and the pH of the solution adjusted to 6.7. The powders were hydrated at 40 °C, and allowed to stabilize for 4 h. These solutions were diluted 100 times and the casein micelles were adsorbed on to parlodion coated copper grids. These grids were stained using uranyl acetate and oxalic acid, quick frozen in liquefied Freon 22, and freeze dried so that whole casein micelles in a form as close to their native state was imaged. Images were photographed at 50,000 \times , 85,000 \times and 140,000 \times . Casein micelles in non-fat dried milk appeared to have lost its perfect spherical shape forming incomplete spherical shapes with some hollow spots inside the micelle. Calcium caseinate formed large micellar structures which were stained heavily. When acid casein was dissolved in water by the addition of calcium hydroxide, the structure of the calcium caseinate formed was different from the former. These formed smaller particles with irregular shapes. Sodium caseinate did not form any micelles. It formed a network very similar to a gel-like structure. The microstructural changes in caseins from different sources may be attributed to the processing conditions and can be used to correlate its functional properties.

Key Words: Casein Micelle, Microstructure, Dried Milk Products

1582 Effect of SCC on proteolysis and lipolysis of pasteurized fluid milk during shelf-life storage. M. V. Santos*¹, Y. Ma², and D. M. Barbano², ¹Universidade de Sao Paulo, Sao Paulo, SP, Brazil, ²Cornell University, Ithaca, NY.

The objectives of the study were to determine: (1) the time in days for a pasteurized (76°C for 30 s), homogenized 2% milk to develop off-flavor due to lipolysis and proteolysis caused by native milk enzymes associated with milks of different SCC (i.e., about 20,000, 210,000, 410,000, and 750,000 cells/ml) at 0.5 and 6.0°C, independent of microbiological spoilage of milk; (2) if fat content of milk (i.e., 1, 2, and 3.25%) influences the level of proteolysis or lipolysis caused by native milk enzymes; and (3) the number of days for 2% fat milk made from milks of differing SCC to develop off-flavor due to the combination of the action of native milk enzymes and microbial growth. Lipolysis was determined by the copper soap method. Proteolysis was by the Kjeldahl method using the decrease in casein as a percentage of true protein as an index of proteolysis during 61 d of storage. There was a significant effect of SCC and temperature of storage on fat and protein degradation by native milk enzymes in pasteurized 2% fat milk. Based on previous data for flavor and objective measures of lipolysis and proteolysis (JDS 83:264-274), the milk flavor in the present study would have been unacceptable at about 14 and 42 d for the high SCC milk and 49 and > 61 d for the low SCC milk, at 6 and 0.5°C, respectively. Fat concentration in milk had an impact on lipolysis, with both the level and rate of increase of FFA content increasing with increasing fat content. The combined effect of microbial growth plus native milk enzymes on lipolysis and proteolysis was larger at 6 than 0.5°C. Generally, low SCC milk spoiled due to microbial growth, not native milk enzyme action, by 26 days at 6°C, while high SCC milk had levels of proteolysis and lipolysis sufficient to produce off-flavor at about d 12, which was prior to microbial failure. At 0.5°C, the microbial counts were < 2000 cfu/ml at day 29 for both low and high SCC milk, but the proteolysis in the high SCC milk was just reaching the level that is sufficient to product off-flavor.

Key Words: pasteurized milk, somatic cell count, proteolysis and lipolysis

1583 Rheological properties of primary stabilizer/milk protein/ κ -carrageenan/sucrose systems simulating ice cream mix. S. Thaiudom* and H.D. Goff, *University of Guelph, Guelph, ON, Canada*.

The influence of primary stabilizers, preparation temperature and the concentration of κ -carrageenan on the rheological behaviour of aqueous systems simulating ice cream mix was studied using dynamic rheological techniques with a controlled stress rheometer. Three different primary stabilizers (locust bean gum (LBG), guar, and xanthan), two heat treatments (69°C/30min and 85°C/30min), and three concentrations of κ -carrageenan (0.0, 0.025, and 0.05% w/w) were fitted to a factorial experimental design. All samples were comprised of 12% (w/w) sucrose and were aged overnight at 4°C before rheological properties were measured at the same temperature. Flow behaviour of all samples with κ -carrageenan showed a thixotropic loop due to the interaction of κ -carrageenan and milk protein whereas samples without κ -carrageenan showed pseudoplastic behaviour. Phase separations were seen in all samples without κ -carrageenan due to depletion-flocculation of primary stabilizers and milk proteins. However, samples with LBG showed less phase separation than samples with guar or xanthan. Storage and loss moduli were governed by type of primary stabilizer, preparation temperature, concentration of κ -carrageenan, and the interactions of these main effects. Storage and loss moduli increased significantly with both increasing concentration of κ -carrageenan and/or preparation temperature at 85°C. This is presumably due to either the gelation of κ -carrageenan or the interaction between κ -carrageenan and milk proteins inducing solid-like characteristics. Samples comprised of xanthan with or without κ -carrageenan showed significantly higher storage moduli than the samples with guar or LBG, probably due to self-association of xanthan to form a weak gel in the system. However, loss moduli of samples comprised of xanthan with 0.025 or 0.05% (w/w) κ -carrageenan were very small, possibly due to κ -carrageenan gelation or enhanced self-association of xanthan, resulting in less liquid-like behaviour. Thus, we have concluded that the addition of κ -carrageenan has developed a more elastic in the aqueous solution.

Key Words: rheology, milk protein, κ -carrageenan

1584 Control of acidification of yogurt by microencapsulated bacteriocin. J. Y. Imm*¹, S. J. Oh², J. S. Kim¹, and S. H. Kim³, ¹*Korea Food Research Institute*, ²*Korea Yakult Co. Ltd.*, ³*Korea University*.

The purpose of this study was to examine the effect of microencapsulated bacteriocin to control excessive acidification of yogurt. *Lactococcus* sp. KU109, a bacteriocin producer was isolated from swiss cheese and crude bacteriocin was prepared by lyophilization of *Lactococcus* sp. KU109 culture grown in 10% skim milk containing 1% glucose. Bacteriocin powder was encapsulated with acid release coating material, Eudragit EPO by surface reforming method (hybridization). Yogurt was made by adding 0.02% (w/w) commercial starter to pasteurized 12% reconstituted milk either with (0.5, 1 and 1.5%, w/w) or without incorporation of encapsulated bacteriocin. The size and appearance of encapsulated bacteriocin was observed using scanning electron microscopy and the effect of incorporated bacteriocin on viable cells, pH and titratable acidity (TA) was monitored during incubation at 42°C for 24 h. The encapsulation with formulation ratio of 9:1 (bacteriocin:Eudragit EPO, w/w) formed sphere shaped particles of smooth surface with mean size of 25 μ m. The activity of 1.5% bacteriocin was 100 AU/mL. There was no substantial difference in time to reach pH 4.6 and the pH after 6 h incubation was ranged from 4.56 to 4.69. More than 6 h incubation, yogurt containing bacteriocin started showing difference in pH and the amount of acid production. The pH and TA of control yoghurt were 3.97 and 1.29% after 24 h whereas they were 4.25 and 1.16% in yogurt containing 1.5% encapsulated bacteriocin. The incorporation of bacteriocin in yogurt significantly inhibited the growth of *L. bulgaricus* and the extent of inhibition was increased as the concentration of bacteriocin increased. After 9 h incubation, growth of *L. bulgaricus* was resulted in 2 log reduction in the presence of 1.5% bacteriocin. However, the growth of *S. thermophilus* showed only 0.5 log reduction during incubation. The result suggests that the microencapsulated bacteriocin has potential to control excessive growth of *L. bulgaricus* caused by temperature abuse or post-acidification.

Key Words: bacteriocin, encapsulation, yogurt

1585 Consumer evaluation of "high-CLA dairy products" produced from cows fed fish oil. S. T. Franklin, L. J. Maynard, A. Pasley, and M. C. Newman, *University of Kentucky, Lexington, KY*.

Milk from cows fed fish oil contains high concentrations of conjugated linoleic acid (CLA) and increased n-3 fatty acids. Dairy products processed from this milk could provide substantial health benefits for consumers, however, questions exist as to the taste of dairy products produced from cows fed fish oil. Thus, eight Holstein cows in late lactation were assigned to treatments of a control (C) diet or a diet containing fish oil (FO) at 2% of dry matter in a 2 X 2 Latin square design. Cows were moved to a tie-stall barn 1 wk prior to the start of the trial to allow for acclimation. Each period consisted of 4 wk, with 2 wk for acclimation to the diets. Milk was collected from cows during the last 2 wk of each period and processed into butter, yogurt, and 2% milk. Products processed during the second period were allocated into individual samples for blind taste test by 111 consumers. Consumers also answered surveys concerning willingness-to-pay for products containing high CLA. Results of the consumer taste tests were that 34% of the consumers preferred the C milk, 21% preferred the FO milk, and 45% had no preference; with 60% of the consumers reporting that the taste of the FO milk was acceptable or better compared with 75% for the C milk. For the yogurt, 57% of the consumers reported that the taste of the FO yogurt was acceptable or better compared to 84% for the C yogurt. The flavor of the FO butter was rated as acceptable or better by 77% of the consumers compared to 96% for the C butter. Preference for the FO butter was 18% compared with a 42% preference for the C butter and 40% with no preference. No consumers reported a "fishy" flavor in any of the products. Willingness-to-pay for high-CLA products was correlated with the survey setting, the respondents' status as primary household shopper, gender, and priorities placed on price, fat content, and taste. In conclusion, dairy products made from milk from cows fed fish oil were found by the majority of the participants to be acceptable in flavor and high-CLA products could command a premium price.

Key Words: Conjugated linoleic acid, Dairy products, Fish oil

1586 Sensory and analytical analysis of milk formulations with sweet cream buttermilk. J. Powell*, S.E. Duncan, S.F. O'Keefe, and S.S. Sumner, *Virginia Polytechnic Institute and State University*.

The sensory and analytical characteristics of three dairy beverages were analyzed using two underutilized dairy products, liquid sweet cream buttermilk and dried sweet cream buttermilk, with skim to produce two lowfat (.5%) formulations. A hedonic test was used to measure the overall acceptability of these products as compared to skim milk, and the "just right" test was used to determine if there was a significant difference in flavor color and viscosity among the three samples. Sensory characteristics of nonfat milks were enhanced or changed by adding the liquid buttermilk and the dried buttermilk. The hedonic test showed that on an increasing scale from likes extremely to dislikes extremely, the skim milk scored a five, the liquid buttermilk formulation scored a 4, and the dried buttermilk formulation scored a nine. These results showed the liquid buttermilk formulation was more acceptable than the traditional skim or the dried buttermilk formulation. The average value for the "just right" test with 3 being "just right", showed that for the previously mentioned attributes, the cream and liquid buttermilk were "just right", and the dry buttermilk was evaluated above the "just right" score with a score of 4. Solid Phase Microextraction-Gas Chromatography/Mass Spectrometry was used to elucidate key flavor compound susceptible to light oxidation.

Key Words: Lowfat, Buttermilk, Sensory

1587 Use of Capillary Electrophoresis (CE) to determine metabolic organic acids in milk. Jesus M. Izco*¹, Monica Tormo¹, and Rafael Jimenez-Flores¹, ¹*Dairy Products Technology Center, Cal Poly*.

The aim of this work is to optimize a CE method for the simultaneous determination of eleven metabolically important organic acids (oxalic, citric, formic, succinic, orotic, uric, pyruvic, acetic, propionic, lactic and butyric). This method was tested to evaluate carbohydrate catabolism in lactic acid bacteria and *Bacillus* spp. Organic acids have little or no

UV absorbance, thus indirect UV detection is necessary. Also, a surfactant was used to avoid electroosmotic flow. The separation was carried out on an uncoated capillary (110 cm, 75 μ m I.D.) at 20kV for 18 min. Running buffer was tested at different pH values between 5.0 and 12.0. Addition of methanol was tested to improve the separation. Sterilized permeate obtained from skim milk, was inoculated with spores from 4 different strains (*B. licheniformis* 12759 and DPTC bacillus strains 14580, SL3 and CL6) and incubated at 40C in the BactiAlertTM System until detection by the sensor. Sample preparation consisted on treating 1 ml of permeate samples with sulfuric acid 4.5 mM, containing 15 ppm of boric acid as internal standard. Also, yogurt organic acids were analyzed in order to test the versatility of the technique. Good separation for all organic acids was achieved, except for pyruvic and acetic acids, which migrated as a single peak. Linearity was established between 2 and 100 ppm for most of them, with R² values between 0.97 and 0.99. Citric, succinic, orotic, pyruvic-acetic, propionic and lactic acids were detected and quantified in all of the permeate samples. Values of 85031, 557, 778, 783, 4810 and 1365 ppm respectively were found in sterilized permeate. Depending on the strain, different profiles have been defined. In the case of *B. licheniformis* 12759, the peak area of most organic acids was reduced, indicating a different metabolism. In yogurt, this test showed no presence of butyric acid, the lactic acid peak prevented quantification of propionic acid, and the rest of them were quantified successfully. The proposed method is useful to analyze the metabolism of different bacteria grown in milk substrates giving us a rapid tool to evaluate the quality of dairy products during manufacturing and storage.

Key Words: Organic acids, Capillary Electrophoresis, Dairy products

1588 Effect of addition of whey protein concentrate in the manufacturing of set yogurt. S. C. G. Lima, A. J. Petenate, and M. L. Gigante*, *State University of Campinas, Campinas, SP/Brazil.*

The increase in the level of milk solids used in the manufacturing of yogurt aims to improve the firmness and to reduce product syneresis. The object of this study was to compare the firmness, susceptibility to syneresis and pH of set yogurts manufactured with the addition of skim milk powder (SMP) or whey protein concentrate (WPC) in different concentrations. A Split-Plot design with tree replicate was used. The milk was divided into portions and five treatments were applied at random in the portions. The treatments were the following: without addition of solids and with addition of SMP or WPC in order to increase the level of solids to 13 and 15%. Set yogurts were stored in plastic container at 4°C and randomly chosen after 1, 8, 16 and 23 d. and analyzed for firmness, susceptibility to syneresis and pH. After the manufacturing, the set yogurts were analysed for total solids, protein, fat, lactose and ash. The set yogurts without the addition of solids, with the addition of SMP or WPC in order to increase the level of solids to 13 and 15% presented, respectively, 11.13, 13.01, 14.98, 13.04 and 15.04% of total solids. Set yogurts with SMP were significantly firmer and the firmness of all products increased significantly during storage. Set yogurts with WPC and 13% of total solids presented significant reduction of syneresis during storage, differing from the others which presented a significant increase of syneresis during storage. Products to which SMP or WPC were added in order to increase the level of solids to 15% presented, respectively, the greatest (29.86) and the smallest (9.13) percentage of increase of syneresis during storage. The treatment did not significantly influenced the post-acidification of the products, which was significantly influenced by storage duration. The substitution of SMP for WPC to increase the level of solids in milk used for the manufacturing of set yogurt resulted in less firm products, with less syneresis and no change in post-acidification.

Key Words: set yogurt, WPC, syneresis

1589 Texture Profiling of Skim Milk and Carrageenan Solutions. N.R. Pollen*¹ and C.R. Daubert¹, ¹*North Carolina State University.*

The texture profile of skim milk and carrageenan solution has been studied using rheological and sensory techniques. Three rheological properties were considered to characterize sensory properties of fluid foods: yield stress, steady shear viscosity at 50 s⁻¹, and extensional viscosity. All analyses were performed at 25°C on skim milk samples stabilized

with κ and λ - carrageenan blends of 50/50, 33/67, and 25/75 in addition 100% pure κ and λ -carrageenan. All solutions were tested between the concentration range of 0-0.20% (wt/wt), with 0% as pure skim milk. Steady shear viscosity as well as yield stress were determined using a Haake VT550 viscometer with a concentric cylinder or vane attachment, respectively. Shear rates were ramped from 0 to 100, then back to 0 s⁻¹. Extensional viscosity was measured using a specifically designed tube viscometer of expandable- length tubing, 5.08 cm in diameter. Fluids exited these vertically hanging tubes through small holes with a radius ranging from 0.5 to 10 mm. Pressure drop, flow rate, and strain rate at a constant entrance angle (90°) were measured for extensional flow calculations. As anticipated, results supported the direct relationships between carrageenan concentration and viscosity and yield stress. Also expected, κ -carrageenan formed the strongest gels at all concentrations. The extensional viscosity of solutions containing λ -carrageenan produced higher Trouton ratios, indicating the λ -carrageenan molecule was more readily extendible. Preliminary sensory results of mouthfeel viscosity and finger characterization of stringiness correspond with rheological testing; these correlations support the selection of the fundamental rheological parameters as predictors for sensory response for fluid food systems.

Key Words: Texture Profiling, Extensional Viscosity, Carrageenan

1590 Effect of sterilization on physical properties of recombined milk. G. Prez-Hernandez, B. Magaa-Ypez*, and R. L. Richter, *Texas A&M University, College Station, TX.*

The objective of this research was to determine the effect of retort sterilization on some physical characteristics of the emulsion and on particle size parameters of the emulsion. Emulsions containing casein to whey protein ratios of 80:20, 60:40, 40:60, 0:100, and 0.5% monoglycerides, 0.5% lecithin, or a mixture of lecithin with monoglycerides were homogenized at 20 and 90MPa. The protein and fat concentrations of the milk were 3%. Stability index, pH, viscosity and particle size distribution parameters were measured before and after sterilization at 121°C for 15 min. The heat treatment lowered the pH from 6.63 to 6.57 (p \leq 0.0001). Viscosity was affected by the interaction between the heat treatment and the casein:whey protein ratio (p \leq 0.0001). Viscosity increased from 2.62cp to 7.46cp for the sample that contained only whey protein, but differences in viscosity for other ratios of casein to whey protein were not found. The volume surface average diameter was affected by the interaction between heat treatment and casein:whey protein ratio. The volume surface average diameter increased from 0.4663 μ m before heating to 1.058 μ m after heating in the sample with casein to whey protein ratio of 40:60 (p \leq 0.06), and from 0.5309 μ m before heating to 1.7168 μ m after heating for the sample with 100% whey protein (p \leq 0.0003). The surface area of particles increased in the samples that contained 80 and 60% of the protein as casein during heating at both homogenization pressures, but decreased in the sample which had a casein to whey protein ratio of 40:60 homogenized at 90 MPa and with the sample that did not contain casein homogenized at 20 and 90MPa. Particle size surface area decreased after heat treatment in the samples with casein to whey protein ratios of 40:60 and 0:100 when the samples contained emulsifier. However, the decrease in surface area of the particles was significant only for the sample that contained no casein. The stability index increased after sterilization for all treatments containing emulsifiers.

Key Words: Recombined milk, Sterilization, Emulsion

1591 Selection of Cows Producing Fat of Low- and High-atherogenicity and the properties of butter and cheese made from their milk. She Chen¹, Shelly Zimmerman¹, Earl Hammond¹, Gene Freeman¹, David Kelley¹, Naomi Scott², Cindie Luhman², and Donald Beitz*¹, ¹*Iowa State University,* ²*Land O'Lakes/Farmland.*

Milk fat from approximately 330 cows from Iowa State University and Land O'Lakes/Farmland herds was analyzed for fatty acid composition. The index of atherogenicity (IA) of each fat sample was calculated by using the formula of Ulbricht and Southgate (Lancet 338:985, 1991): IA=[% lauric + 4(% myristic) + % palmitic] / % unsaturated acids. Milk fat ranged from 1.1 to 4.0 in IA. Four cows from both herds with highest and lowest IAs were selected. Milks from low-IA and high-IA cows and bulk tanks were pasteurized and converted into butter and Cheddar and provolone cheeses. Flavor notes of products were identified and scored by taste panels. Texture of butter and cheeses was

measured with a Texture Analyzer. Butters were achieved with low-IA (1.5), high-IA (2.3), and bulk tank-IA (1.9). Corresponding values for Cheddar were 2.1, 3.4, and 2.4 and for provolone 1.6, 2.6, and 2.1. Panels detected no differences in flavor notes for the three IA types of butter. For Cheddar, sour and bitter flavor notes approached but did not achieve significance at 0.05. Provolone showed differences in buttery flavor, with both high- and low-IA being significantly less than bulk tank. High-IA

butter was harder than low-IA butter as measured by penetration and creep. Similar differences were observed in the hardness of Cheddar and provolone cheeses, with high-IA being harder than low-IA. Seemingly, cows that give milk fat with a low IA will yield butter and cheeses with insignificant differences in flavor but slightly softer textures.

Key Words: Milk Fat, Butter, Cheese

ASAS/ADSA Physiology: General Physiology

1592 Influence of corticotropin-releasing hormone (CRH) on the expression of steroidogenic acute regulatory (StAR) protein in neonatal pigs derived by Caesarian section or natural birth. J.A. Carroll^{*1}, D. Alberts², D.J. Parzik², D.M. Stocco^{2,3}, and T.H. Welsh, Jr.^{2,3}, ¹*Animal Physiology Research Unit, ARS-USDA, Columbia, MO*, ²*Texas Tech University Health Science Center, Lubbock, TX*, ³*Texas A&M University, College Station, TX*.

We previously reported that pigs born by Caesarian section (C-section) have greater basal and CRH-induced cortisol (CS) secretion compared to natural birth pigs. This study evaluated potential differences in StAR protein and cytochrome P450 side-chain cleavage enzyme (P450scc) protein expression in C-section pigs which may have contributed to this altered CS secretion. Eight crossbred sows were selected for the study (n = 4 natural birth and n = 4 C-section). Gestation length did not differ between natural birth and C-section pigs (113.6 ± .1 and 113.2 ± .3 d, respectively). Blood and tissue samples from 38 pigs were collected at birth. Remaining pigs were sustained with natural birth sows until 2wk of age (n = 39). At 2wk of age, pigs were non-surgically cannulated for blood sample collection to assess pituitary-adrenal responsiveness to porcine CRH (10 µg/kg). Blood samples were collected at -30, -15, 0, 5, 10, 20, 40, 60, and 90 min, with CRH or saline given at Time 0. Total RNA was isolated from the pituitary and adrenal glands to evaluate mRNAs specific for pro-opiomelanocortin (POMC) and for the ACTH receptor. Adrenocortical samples were used in Western blot procedures to determine StAR and P450scc protein content. While basal serum concentration of CS was not different at birth (P = .86), adrenocortical expression of StAR protein was lower (P < 0.0001) in C-section pigs as compared to natural birth pigs. Interestingly, serum ACTH (P = 0.0008) and ACTH receptor mRNA (tendency; P < 0.06) were greater in C-section pigs, suggesting a compensational effect due to the reduced expression of StAR protein in these pigs. A developmental decrease was observed in serum CS (P < 0.0001) and ACTH (P < 0.044), while a developmental increase was observed in POMC mRNA (P < 0.0001). ACTH receptor mRNA expression tended (P < 0.07) to decrease with age. Both, serum concentration of CS and StAR protein expression were increased following the CRH challenge (P < .05) whereas no change was detected in P450scc protein expression. Type of birth, age, and CRH challenge each influenced the correlations among various components of the HPA axis. These data suggest an important role for StAR and P450scc adrenocortical proteins in mediating developmental- and hormonal-induced changes in CS synthesis and secretion in the young pig.

Key Words: StAR protein, Cortisol, Pigs

1593 Hepatic corticosteroid-binding globulin (CBG) mRNA expression and plasma CBG levels in pigs in response to social and heat stress. J. Heo^{*1}, H. G. Kattesh¹, M. P. Roberts¹, R. L. Matter², J. L. Morrow³, and J. W. Dailey³, ¹*University of Tennessee, Knoxville TN*, ²*ARS-USDA, Columbia MO*, ³*ARS-USDA, Lubbock TX*.

Plasma cortisol, CBG, hepatic CBG expression, and other physiological as well as behavioral measures of stress were studied in pigs in response to elevated temperature in conjunction with establishing social hierarchy. Twenty-four pigs (four pigs/litter) were weaned at 25 days of age and housed by litter for 2 wk at 23 ± 2°C. On d 0, animals were weighed and placed under general anesthesia for collection of blood (10 ml) and liver tissue (~100 mg). On d 1, three pigs of similar weight (23 ± .9 kg) but from different litters were allotted to eight nursery pens within two environmentally controlled rooms (12 animals/room). One room was maintained at 23 ± 2°C (CONT) and the other at 33 ± 2°C (HEAT). On d 8-14 both rooms were maintained at 23 ± 2°C (REC). Animals were videotaped for 72 h beginning on d 1 and 8 to document

behavioral changes in response to room temperature and to determine social order. Blood and liver tissue were collected again on d 7 and 14. Data was analyzed as a randomized complete block design using Proc Mixed procedure of SAS. Plasma haptoglobin increased (467.2 ± 122.5 vs 763.4 ± 112.9 ug/ml; d 0 vs d 7, P<.05) and cortisol and CBG decreased (9.92 vs 8.51 ± .83 ug/dl, 11.41 vs 9.93 ± 1.07 ug/ml; d 0 vs d 7, respectively, P<.05) in the HEAT group. Hepatic CBG mRNA level and neutrophil: lymphocyte ratio were not affected (P>.1) by treatment. HEAT pigs displayed increased (P<.01) drinking but reduced feeding (P<.01) and lying in contact with other pigs (P<.05) behaviors. ADG tended (P=.06) to be lower for HEAT (.64 ± .06 kg/d) compared to CONT (.82 ± .06 kg/d) pigs. During REC, HEAT pigs had similar (P>.1) ADG, plasma cortisol, CBG, haptoglobin, and drinking and feeding but increased (P<.01) lying with contact behaviors compared to CONT. Measured physiological and behavioral responses were not related to social status. These results indicate that reduced circulating levels of cortisol and CBG in pigs following 7-d exposure to elevated temperature may not be determined by hepatic CBG mRNA expression.

Key Words: Pig, Heat stress, CBG

1594 Cold-induced changes in brown adipose tissue (BAT) composition and iodothyronine 5'-deiodinase (5'D) activity in newborn Angus and Brahman calves. S.J. Falck^{*1}, G.E. Carstens¹, S. Kahl², S.R. Busch¹, L.J. Slay¹, C.D. Gilbert¹, and S.B. Smith¹, ¹*Texas A&M University, College Station, TX*, ²*USDA, Agricultural Research Service, Beltsville, MD*.

We previously found that newborn Brahman (BR) calves generate less heat from BAT in response to a norepinephrine challenge than Angus (AN) calves even though BAT 5'D activities (converts thyroxine, T₄ to triiodothyronine, T₃) were higher in BR calves. The aim of this study was to further characterize 5'D in newborn calves, and to examine breed effects on cold-induced changes in BAT composition, 5'D activity, and plasma T₃ and T₄ levels. AN (n = 15) and BR (n = 20) calves were each assigned to 1 of 3 postnatal treatments: newborn (N), cold (C) and warm (W) calves. Newborn calves were killed at 9 h of age, whereas, C and W calves were killed after 48 h of exposure to 4 and 20°C. Rectal temperature (RT) and blood samples were collected at 0, 12, 24 and 48 h, and plasma analyzed for T₃ and T₄. Deiodinating activity of BAT was determined by quantifying ¹²⁵I⁻ released from ¹²⁵I-labeled reverse-T₃ using assay conditions for type I (5'D-I) and type II (5'D-II). RT were higher (P < .01) in AN calves at time 0 (38.8 vs 38.1 ± .16°C, but were similar to BR calves thereafter. BR calves had higher plasma T₃ (61%; P < .001) and T₄ (31%; P < .05) levels than AN calves, but plasma T₃ increased more due to cold in BR (62%; P < .001) than AN (10%; P = .80). Overall, plasma T₄ levels were 31% higher (P < .001) in C than W calves. Compared to AN calves, BR had less (P < .05) BAT lipid at birth (2.12 vs 1.33) and after C (1.95 vs .63), but similar amounts after W treatment (2.32 vs 1.89 ± .28 g/kg BW). Cytochrome c oxidase activity (µmol/min/g BAT) was unaffected by breed and was 68% higher in C than W calves. BAT 5'D-I activity was higher (P < .001) in BR calves at birth (.53 vs .95 ± .01 nmol I/h/mg protein), but not after C or W treatment. Cold decreased (P < .01) 5'D-I activity 29% in BR calves, but numerically increased 5'D-I in AN calves. 5'D-II activity was higher (P < .001) in BR calves (.29 vs .94 ± .12 pmol I/h/mg), but was unaffected by postnatal treatment. The results suggest that although BR calves mobilize BAT lipid more rapidly during cold exposure, this substrate is not effectively used to support BAT thermogenesis.

Key Words: Brown Fat, 5'-Deiodinase, Thyroid Hormones

1595 Growth rates of Holstein heifers fed diets differing in amounts of protein, energy and protein:energy ratios and treated or not with bST. M. Liboni*, T.I. Belloso, M.S. Gulay, M.L. Schairer, M.J. Hayen, L.C. Teixeira, K.C. Bachman, and H.H. Head, *University of Florida*.

One hundred and twenty Holstein heifers were assigned to one of four diets (30/diet) and bST treatments in a 2x2x2 factorial arrangement of treatments beginning when they were 120 d of age. Diets were formulated to contain 14 or 19% CP with energy concentrations of 100% and 110% of daily requirements (NRC,1989) for each CP percentage. These diets were fed once daily in quantities to meet desired average daily weight gains (ADG) of 0.81 kg for diets with 14% CP and 1.09 kg for diets with 19% CP. The g of CP/Mcal ME for the four diets were held constant throughout the trial at 50, 55, 65 and 73, respectively. When heifers reached 341 Kg BW they then were transferred to the breeding herd. Heifers were raised in 8 groups of 10 heifers each and 2 groups of 20 heifers each. All heifers were weighed and height at withers measured when assigned to trial and then weekly thereafter. One-half of the heifers in each group was injected with bST (POSILAC[®], 500 mg bST/1.4 ml, Monsanto) biweekly in the following amounts: 0.2 ml up to 181 Kg BW, 0.3 ml between 182-273 Kg BW, and 0.4 ml above 273 Kg BW. These volumes provided about 5.1, 7.6 and 10.2 mg bST/d. Average daily weight gains (kg/d) of heifers on the four diets were 0.89, 0.01, 0.97, 0.01, 1.03, 0.01 and 1.02, 0.01. The ADG for the four diets differed ($P < 0.0001$). At 341 Kg BW the average ages of heifers fed the four diets were: 365, 4.63, 368, 4.00, 337, 4.00 and 356, 4.00 d. Difference in the average age to reach 341 Kg was significant ($P < 0.0003$). Average total height increases (AHI, cm) during the time period heifers were on experiment were 28.46, 0.69, 31.79, 0.70, 31.78, 0.70 and 34.62, 0.70, respectively. The AHI for the four diets differed ($P < 0.05$). Overall, there were significant positive effects of bST on ADG ($P < 0.0129$) and AHI ($P < 0.0898$) for heifers fed the four diets. Injections of bST reduced the number of days for heifers to reach 341Kg for the two high energy diets compared to uninjected heifers fed the same diets ($P < 0.0611$), but not for the lower energy diets. Considering the whole growth period, no significant effects of season of birth of heifers were detected on age to reach 341 Kg, ADG or AHI. No season of birth x bST interaction was detected for any growth measure.

Key Words: Heifer, Protein:energy, Growth

1596 Hepatic oxidative metabolism in lactating dairy cows is modulated by increasing doses of intravenous lipopolysaccharide. M. R. Waldron*¹, T. Nishida¹, B. J. Nonnecke², and T. R. Overton¹, ¹Cornell University, Ithaca, NY, ²National Animal Disease Center, USDA ARS, Ames, IA.

The effect of intravenous lipopolysaccharide (LPS; *E. coli* O11:B4) infusion on liver metabolism in twelve multiparous midlactation cows (150-220 DIM) was investigated. A covariate liver sample was obtained via percutaneous trochar biopsy 7 d prior to LPS infusion. Liver slices were used *in vitro* to determine hepatic capacities for conversion of [¹⁻¹⁴C]propionate, [¹⁻¹⁴C]alanine, and [¹⁻¹⁴C](L+)-lactate to CO₂. Hepatic capacities for conversion of [¹⁻¹⁴C]palmitate to CO₂, acid soluble products (a proxy for ketone body production), and stored esterified products also were determined. Seven days later, cows were intravenously infused with either 0 (n=6), 1.0 (n=4), or 2.0 (n=2) μg LPS/kg BW dissolved in 100 ml sterile physiological saline during a 100-min infusion. Saline infused cows were pair-fed with LPS-infused cows during the infusion period to eliminate effects of feed intake with LPS treatment. Liver was biopsied at 4.5 h after the beginning of infusion and metabolic incubations were conducted as described for covariate samples. Differences in the capacities of liver from control and LPS-infused cows to convert [¹⁻¹⁴C]palmitate to CO₂, acid soluble products, and stored esterified products were not significant ($P > 0.20$). However, LPS infusion tended to increase the capacity of liver to convert [¹⁻¹⁴C]propionate (4.19, 4.23, 6.07 μmol/h x g wet weight; $P < 0.12$) and [¹⁻¹⁴C](L+)-lactate (0.66, 0.98, 1.00 μmol/h x g wet weight; $P < 0.06$) to CO₂ for 0, 1.0, and 2.0 μg LPS/kg BW, respectively. Differences in hepatic capacity to convert [¹⁻¹⁴C]alanine to CO₂ were not significant ($P > 0.20$). These data suggest that aspects of hepatic carbohydrate metabolism in lactating dairy cows are affected by the inflammatory response elicited by LPS infusion; however, effects of the inflammatory

response on hepatic fatty acid metabolism in midlactation cows appear to be minimal.

Key Words: Liver Metabolism, Lipopolysaccharide, Immune System

1597 Circulating leukocyte populations, serum cytokines and plasma vitamins A and E in mid-lactation dairy cows infused with varied doses of lipopolysaccharide (LPS). B. J. Nonnecke¹, M. R. Waldron*², T. Nishida², T. R. Overton², and R. L. Horst¹, ¹National Animal Disease Center (NADC), USDA ARS, Ames, IA, ²Cornell University, Ithaca, NY.

Four multiparous lactating cows were used in 4 x 4 Latin square design to assess effects of LPS (serotype *E. coli* O11:B4 at 0.0, 0.5, 1.0, 1.5 μg/kg BW) on blood leukocyte populations, cytokines (TNF-α and IFN-γ) and vitamins [retinol,RRR-α-tocopherol and β-carotene (provitamin A)]. LPS, in 100 ml of physiological saline, was infused IV at 1 ml/min over 100 min. Blood was collected by jugular catheter immediately before infusion (0h) and at 2 (leukocytes not sampled at this time), 4, 6, 24 and 48h. Samples were shipped overnight to the NADC for analysis. Blood leukocytes were phenotyped by flow cytometry and the cytokines and vitamins were quantified by ELISA and reverse-phase HPLC, respectively. LPS infusion caused a marked leukopenia at 4 and 6 h that was characterized by a reduction in the number of T cells (CD3⁺, CD4⁺, CD8⁺ and γδTCR⁺ subsets), B cells, monocytes and cells expressing IL-2 receptors and MHC class II antigens. By ≥24h, values were comparable to preinfusion and control-cow values. Interestingly, percentages of B cells and γδTCR⁺, IL-2r⁺ and MHC class II antigen⁺ cells in leukocyte populations from LPS-treated cows were elevated at 4 and 6 h. Serum TNF-α was affected by infusion of LPS in a dose-dependent fashion, with maximal concentrations occurring at 2 h. TNF-α concentrations in these cows declined precipitously from 2 to 6 h and were not different from preinfusion values or those of control cows at ≥24h. Serum IFN-γ, extremely low throughout the experimental period, was unaffected by LPS. Plasma retinol, RRR-α-tocopherol, and β-carotene also were unaffected by LPS. These results and metabolic data presented in the companion poster suggest LPS-induced inflammation influences broad aspects of the immune system, affecting the metabolism of dairy cows.

Key Words: Lipopolysaccharide, Vitamins A and E, Immune Function

1598 Metabolic responses of lactating dairy cows to intravenous infusion of increasing amounts of lipopolysaccharide. M. R. Waldron*¹, T. Nishida¹, B. J. Nonnecke², and T. R. Overton¹, ¹Cornell University, Ithaca, NY, ²National Animal Disease Center, USDA ARS, Ames, IA.

Four multiparous lactating cows (175-220 DIM) were used in a 4x4 Latin square design to assess the effects of increasing doses (0.0, 0.5, 1.0, 1.5 μg/kg BW) of lipopolysaccharide (LPS; *E. coli* O11:B4) on performance and blood metabolites. Treatments were dissolved in 100 ml of sterile saline and infused intravenously over a period of 100 min. Milk production was decreased linearly for 24 h after LPS infusion (34.9, 22.4, 22.0, and 16.5 kg; $P < 0.001$) and generally returned to preinfusion levels by the sixth milking following LPS infusion. The DMI also was decreased linearly for 24 h following LPS infusion (21.2, 17.6, 15.5, and 10.9 kg; $P < 0.01$) and regained preinfusion levels 3 d following infusion. Blood was sampled immediately before infusion (0 h), at 60-min intervals for 8 h, and at 24 and 48 h postinfusion. Reported means for hormone and metabolite concentrations with treatment by time effects are at the 3 h timepoint. Plasma insulin (1.54, 1.64, 2.37, and 3.88 ng/ml), glucagon (80.6, 204.0, 249.3, and 326.3 pg/ml), and cortisol (0.14, 1.16, 1.51, and 1.79 ng/ml) concentrations increased linearly following LPS infusion (treatment by time, $P < 0.01$). Plasma (L+)-lactate concentrations (5.83, 7.43, 7.95, and 6.63 mg/dl) increased following LPS infusion (treatment, $P < 0.001$). There was a linear decrease (treatment by time, $P < 0.01$) for plasma BHBA (9.8, 5.3, 4.4, and 2.9 mg/dl) after infusion. Plasma NEFA were increased by the 1.5 μg LPS/kg BW treatment (204, 185, 198, and 260 mg/dl for 0.0, 0.5, 1.0, 1.5 μg LPS/kg BW, respectively; $P = 0.037$). There was no effect of LPS infusion on plasma glucose concentrations ($P > 0.2$). These data suggest that the inflammatory response elicited by LPS has dose-dependent metabolic consequences that may be important for metabolic health in dairy cows.

Key Words: Lipopolysaccharide, Hormones, Metabolites

1599 Propionibacteria as a direct fed microbial: effects on the insulin-like growth factor system and reproduction in early postpartum dairy cows. C. C. Francisco*, D. N. Waldner, C. S. Chamberlain, and L. J. Spicer, *Oklahoma State University, Stillwater, OK.*

This study was designed to investigate the effects of supplementing a direct fed microbial, Propionibacteria culture (*P. acidipropionici*) to the diets of postpartum cows on plasma IGF-I and IGF-I binding protein (IGFBP) concentrations and reproduction during the first 12 wk of lactation. Pluriparous Holstein cows (n=19) were individually fed a TMR and randomly assigned to either a control or treatment group. Each of the treated cows (n=9) received 17 g of Propionibacteria culture daily from -2 to 12 wk postpartum. In blood samples collected twice a week, plasma IGF-I and IGFBP concentrations did not differ between the two groups of cows, however, IGF-I concentrations increased (P<0.001) by fourfold from 1 to 12 wk postpartum. For both groups of cows, plasma IGFBP-3 concentrations at wk 1 were 14% and 15% lower (P<0.001) than at wk 6 and 12, respectively. Plasma IGFBP-2 concentrations at wk 6 and 12 were 19% and 27% greater, respectively, than wk 1, and plasma IGFBP-5 concentrations were 32% and 33% greater (P<0.001) at wk 6 and 12, respectively, than wk 1. Propionibacteria-treated and control cows had similar concentrations of progesterone peak and area under the progesterone curve during first and second postpartum estrous cycles. Interval to first and second postpartum ovulations did not differ between treated and control cows. Feeding Propionibacteria to early lactating cows did not affect the changes in the plasma profiles of IGF-I and IGFBP nor did it affect reproductive function.

Key Words: Propionibacteria, Insulin-like Growth Factors, Reproduction

1600 Propionibacteria as a direct fed microbial: effects on energy balance, milk production, milk components, metabolic hormones and metabolites in early postpartum dairy cows. C. C. Francisco, D. N. Waldner*, C. S. Chamberlain, R. P. Wettemann, and L. J. Spicer, *Oklahoma State University, Stillwater, OK.*

The objective of this study was to determine the effects of directly feeding Propionibacteria culture (*P. acidipropionici*) on energy balance (EB), milk yield, metabolic hormones and metabolites in early lactating cows. Pluriparous Holstein cows (n=19) were individually fed a TMR and randomly assigned to either a control or treatment group. Each of the treated cows (n=9) received 17 g of Propionibacteria culture daily from -2 to 12 wk postpartum. Calculated EB of cows supplemented with Propionibacteria (-7.3±1.5 Mcal/d) tended to be greater (P<0.10) than control cows (-11.4±1.5 Mcal/d) during wk 1 of lactation. Fat-corrected milk and DMI were not affected by treatment. BCS at wk 4 and 10 postpartum did not differ (P>0.50) between groups. Cows fed Propionibacteria had greater (P<0.05) percentages of milk protein (5.0±0.15% vs. 4.0±0.14%) and SNF (10.5±0.15% vs. 9.7±0.14%) than control cows during wk 1 of lactation. Percentages of milk fat and lactose were not influenced by treatment. In plasma samples collected twice a week, NEFA concentrations at wk 1 were greater (P<0.01) in treated than control cows. Plasma leptin concentrations tended to be greater (P<0.10) in cows fed Propionibacteria (8.1±1 ng/mL) compared with control cows (5.3±1 ng/mL) during the 12 wk study and did not change with week postpartum. Plasma cholesterol and glucose concentrations were not affected by supplemental feeding of Propionibacteria but both metabolites increased (P<0.05) with week postpartum. Concentrations of plasma insulin were also unaffected by treatment and increased by about twofold (P<0.05) between wk 1 and 12. In conclusion, feeding Propionibacteria culture to early lactating dairy cows increased milk protein and SNF content, and increased plasma NEFA and leptin levels.

Key Words: Propionibacteria, Leptin, Nonesterified Fatty Acids

1601 Administration of bST elevates phosphoenolpyruvate carboxykinase mRNA in lactating dairy cows. J.C. Velez* and S.S. Donkin, *Purdue University West Lafayette, IN.*

Somatotropin (bST) administration increases milk production and a corresponding increase in hepatic glucose output is necessary to meet increased needs for mammary metabolism and lactose synthesis. The objective of this study was to determine the effects of bST on expression of pyruvate carboxylase (PC) and phosphoenolpyruvate carboxykinase

(PEPCK), two enzymes that are critical to the synthesis of glucose in liver. Eighteen cows were randomly allocated to two treatment groups receiving either bST (Posilac®, Monsanto, St. Louis) or saline injections, over 14-day intervals during a 42-d period. Feed intake and milk production were recorded daily and milk composition was determined weekly. Liver biopsies and blood samples were obtained on day seven following the second and third injections. Blood samples were analyzed for non-esterified fatty acids (NEFA) and glucose. Total RNA was extracted from liver biopsy samples and used to determine the abundance of PC, PEPCK, and 18S mRNA using Northern blot analysis. Milk production and dry matter intake were increased (P<.05) for bST treated cows 38.6 vs. 33.8 1.4 kg/day and 27.2 vs. 25.8 0.5 kg/day, respectively. Plasma NEFA was increased due to bST treatment (111 vs. 170 14 μM). Plasma glucose was not affected by bST treatment (P >.05). Treatment with bST increased (P<.08) PEPCK mRNA but not PC mRNA expression. The effect of bST was accentuated with repeated injection cycles (time effect, P <.05). The relative abundance of PEPCK during the third injection interval was elevated 18% compared to control samples. The magnitude of increase in PEPCK mRNA and changes in milk production are of a similar magnitude. The data indicate a slight increase in PEPCK due to bST which may reflect a greater potential for hepatic glucose production.

Key Words: Somatotropin, liver, mRNA expression

1602 Pyruvate carboxylase 5' untranslated region mRNA variants are heterogeneously expressed within and among bovine tissues. C. Agca* and S.S. Donkin, *Department of Animal Sciences, Purdue University, West Lafayette, IN 47907.*

Pyruvate carboxylase (PC) catalyzes the first regulated reaction in the conversion of pyruvate to glucose in gluconeogenic tissue and the use of acetyl groups for fatty acid synthesis in adipose tissue. Multiple transcripts have been identified for rat and human PC mRNA that are the products of a single gene, encode the same protein, but differ with respect to translational efficiencies and exhibit tissue specific expression patterns. Two bovine PC variants containing different 5' untranslated regions (UTR) of the mRNA were previously identified and reported by our laboratory. The objective of this study was to determine the presence of additional variants of bovine PC mRNA and their distribution among bovine tissues. Total RNA was extracted from bovine liver and used in 5' rapid amplification of cDNA ends and reverse transcription (RT) -PCR. Four new 5'UTR variants were identified which share regions of similarity ranging from 68 to 185 bp. In total, six unique 5'UTR have been identified, cloned and sequenced. The 5'UTR clones are designated as bPC5'A, bPC5'B, bPC5'C, bPC5'D, bPC5'E, and bPC5'F and contain 68, 253, 178, 89, 227, and 162 bp respectively. Northern blot analysis indicates that PC mRNA is more abundant in perirenal fat, omental fat, kidney, mammary tissue, brain and liver than muscle, heart and lung. The profile of 5'UTR variants, determined using RT-PCR and primers for the 5' UTR indicates that bPC5'B, bPC5'C, bPC5'D, and bPC5'E are present all tissues although bPC5'D, and bPC5'E are found in reduced quantities in heart, lung and muscle. The variants bPC5'A and bPC5'F are detectable only in adipose tissue, kidney and liver. The data demonstrate the complexity of expression of PC mRNA 5'UTR variant profiles in liver and indicate PC variant expression that is tissue specific. The exclusivity of bPC5'A and bPC5'F suggests control of the PC gene expression that is unique to gluconeogenic and lipogenic tissues.

Key Words: Pyruvate carboxylase, 5'UTR

1603 Differential relationships of metabolic hormones to growth and reproductive development in performance-tested Angus, Brangus, and Brahman bulls. M.G. Thomas*¹, R.M. Enns², D.M. Hallford¹, D.H. Keisler³, B.S. Obeidat¹, C.D. Morrison³, J.A. Hernandez¹, W.D. Bryant¹, R. Flores¹, and R. Lopez-Ordaz¹, ¹New Mexico State University, ²University of Arizona, ³University of Missouri.

Understanding mechanisms that regulate growth and reproduction are important for improving selection strategies in cattle. In this study, Angus, Brangus, and Brahman bulls (n = 7 per breed) of similar age were randomly selected from a group of 65 weanlings. Bulls were then evaluated for 112 d for concentrations of metabolic hormones and metabolites and growth and reproductive traits. Performance data and serum were collected on d 0, 28, 56, 84, and 112. Serum was also collected on d 50

to 59 and 103 to 112. These time periods were titled 56D and 112D periods. Angus bulls were heavier ($P < 0.05$) than Brangus and Brahman bulls on d 56, 84, and 112. Initial and final BW for Angus, Brangus, and Brahman bulls were 292.7, 260.6, 230.4, and 468.3, 435.6, 350.7 kg. Conversely, Brahman bulls had greater hip height ($P < 0.05$) than Brangus with Brangus being taller ($P < .05$) than Angus. Angus bulls had the greatest ($P < 0.05$) scrotal circumference (SC) and Brahman bulls the least. Mean SC across days was 31.5, 29.7, 25.0 cm for the three breeds. Serum testosterone was greater ($P < 0.01$) in Angus and Brangus bulls (10.0 and 8.9 ng/mL) than in Brahman bulls (4.0 ng/mL) throughout the study. Serum concentrations of IGF-I and leptin were greater ($P \leq 0.059$) in Angus bulls on d 56, 84, and 112 than in Brangus and Brahman bulls. Serum concentrations of GH ($P < 0.08$) and glucose ($P < 0.03$) were greater in Brangus bulls relative to Angus and Brahman bulls throughout the study. Prediction analyses suggested that breed and serum concentration of leptin could be used to predict ($P \leq 0.08$) BW and SC ($R^2 > 0.82$) in the 56D and 112D periods. Leptin and breed were also useful in predicting ($P \leq 0.09$) serum concentration of GH and testosterone in the 112D period ($R^2 > 0.32$). Residual correlation with the effect of breed removed indicated that leptin was positively correlated ($r \geq 0.53$, $P < 0.05$) with both SC and serum testosterone. Angus and Brahman cattle differ in phenotype, level of adiposity, and rate of sexual maturity. Data herein suggest that these characteristics could be due to varying mechanisms by which metabolic hormones such as leptin, GH, and IGF-I are regulated. Work supported by NIH-SCORE GMO8136 and NMAES 180674.

Key Words: Bulls, Breed, Leptin

1604 LH and leptin pulsatile secretions are independent in ewe lambs. S.E. Recabarren, A. Lobos, C.A. Vilches*, and P. Munoz, *University of Concepcion, Chillan, Chile.*

It has been proposed that leptin may be a metabolic signal regulating the onset of puberty in females and that stimulates also the secretion of GnRH from the hypothalamus. The objective of this work was to recognize if the secretion of leptin depends on the LH secretion in prepubertal sheep. Spring-born Suffolk ewe lambs of 20 weeks of age ($n=5$) received i.m. a long acting GnRH agonist (Decapeptyl®). Treatment was repeated at 24 and 28 weeks of age. Control lambs ($n=6$) received the vehicle. Pulsatility of LH and leptin was studied at 20 (before Decapeptyl injection), 26 and 30 weeks of age. For that, blood samples were collected at 10-min intervals for 6 hours. LH and leptin were measured in all samples by RIA and pulsatile hormone secretion characteristics assessed by the Cluster program. To further characterize the synchrony between LH and leptin pulses, GnRH (10 ng/kg BW) was injected at 60-min intervals for 6 times in other 5 ewe lambs of the same ages. The LH secretion was diminished in the Decapeptyl treated lambs (D) and was lower than in the control lambs (C) at 26 and 30 weeks of age. The transversal mean of plasma leptin concentrations (ng/mL/6h) did not change in the C lambs. In the D and in the GnRH lambs, mean leptin concentrations were higher ($P \leq 0.05$) at 30 weeks of age than at 20-weeks or 26-weeks. No difference in mean leptin concentrations was observed between groups at any age, except between the C and D lambs at 26-weeks (2.2 ± 0.12 vs 1.42 ± 0.11 ng/mL/6h, $P \leq 0.05$). Amplitude of leptin pulses was higher at 30 weeks of age than at 20 and 26-weeks in the D and GnRH lambs. Between groups, amplitude was higher in the C lambs than in the D lambs (2.6 ± 0.15 vs 1.8 ± 0.13 ng/mL, $P \leq 0.05$) at 26 weeks of age. No change in leptin pulse frequency was observed within and between groups. No coincidence between LH and leptin pulses was observed in any group. Data suggest that pulsatile leptin secretion is independent of LH secretion in ewe lambs. Supported by Fondecyt grant 1990389

Key Words: LH, Leptin, Ewe lamb

1605 Effect of obesity and fasting on leptin secretion and message expression in ewes. J. A. Daniel*¹, B. K. Whitlock¹, J. A. Baker¹, B. Steele¹, C. D. Morrison², D. H. Keisler², T. H. Elsasser³, and J. L. Sartin¹, ¹Auburn University, Auburn, AL, ²University of Missouri, Columbia, MO, ³USDA, Beltsville, MD.

The study was designed to examine the production and secretion of leptin by fat. Ewes (thin to obese) were assigned to either fed (F) or short-term restricted (R) groups. In the first experiment, subcutaneous fat samples were collected from ewes under local anesthesia from just above the last rib. Samples were analyzed for leptin expression using

Northern blotting. In a second experiment, plasma samples were collected for leptin analysis from ewes every 15 min for 24 h beginning 48 h after initiation of feed restriction. Plasma concentrations of insulin, glucose, and NEFA were determined every 6 h. Fat thickness over the last rib was determined by ultrasound (0.025 to 2.18 cm). Expression of leptin mRNA did not differ in F vs. R ewes ($P > 0.14$). Profiles of plasma concentrations of leptin were episodic in nature, and did not differ in a diurnal manner. F ewes had greater leptin mean, area under the curve, number of peaks, peak height, and nadir than R ewes ($P < 0.05$), as determined by CLUSTER analysis. Additionally, F ewes had a shorter interval between peaks ($P < 0.054$). F ewes also had greater concentrations of insulin ($P < 0.01$) and glucose ($P < 0.01$) and lower concentrations of free fatty acids ($P < 0.01$) than R ewes. Fat thickness was correlated with leptin mean ($r = 0.73$, $P < 0.02$), area under the curve ($r = 0.73$, $P < 0.02$), peak height ($r = 0.71$, $P < 0.03$), and nadir ($r = 0.76$, $P < 0.02$) in F ewes and with leptin mean ($r = 0.89$, $P < 0.01$), area under the curve ($r = 0.89$, $P < 0.01$), number of peaks ($r = 0.69$, $P < 0.03$), peak height ($r = 0.87$, $P < 0.01$), and nadir ($r = 0.86$, $P < 0.01$) in R ewes. Fat thickness was also correlated with concentrations of insulin ($r = 0.88$, $P < 0.01$) in R ewes. At the 6-hour time points, leptin was correlated with insulin in F ewes ($r = 0.51$, $P < 0.01$) and in R ewes ($r = 0.59$, $P < 0.01$). These data provide evidence that profiles of plasma concentrations of leptin are episodic in nature and influenced by nutritive state and fat thickness.

Key Words: Leptin, Sheep

1606 Intracerebroventricular melanin-concentrating hormone stimulates food intake in sheep. B.K. Whitlock*¹, L.A. Daniel¹, D.F. Buxton¹, F.C. Buonomo², C.J. Dyer², and J.L. Sartin¹, ¹Auburn University, ²Monsanto Company.

Melanin concentrating hormone (MCH) is a peptide that is present in the sheep hypothalamus and stimulates feeding when injected intracerebroventricularly (i.c.v.) into rat brains. To clarify its role as a regulator of food intake in ruminants, we investigated the effect of MCH injected i.c.v. in sheep. The doses of MCH used were derived from previous experiments in our lab with neuropeptide Y (NPY), a known appetite regulator in sheep. Six, castrate male sheep were satiated and then received one of six treatments [saline and either 0.243, 2.43 or 12.1 µg/kg MCH, or MCH + NPY (0.243 and 0.432 µg/kg, respectively)] injected i.c.v. over 30 s. Food intake was measured for 2 h before and at 2, 4, 6, 8, 12, and 24 h after i.c.v. injection. In the second experiment, the same sheep were satiated and received one of four treatments [saline, 0.243, or 2.43 µg/kg MCH, and NPY (0.432 µg/kg)] injected i.c.v. over 30 s, then infused i.c.v. hourly for 6 h (500 µl/h). Food intake was measured for 2 h before and at 2, 4, and 6 h. Serial blood samples were collected at 15-min intervals from 2 h to 6 h relative to i.c.v. injection. In the first experiment, all doses of MCH resulted in greater ($P < 0.05$) food intake than saline or NPY, while NPY did not ($P = 0.36$) affect food intake relative to controls. In the second experiment, food intake was increased ($P < 0.03$) in sheep given the higher dose of MCH and in NPY treated sheep. Concentrations of nonesterified fatty acids (NEFA) were not ($P = 0.47$) affected by treatment. We conclude that a single i.c.v. injection of MCH stimulates an increase in food intake in sheep. Moreover, i.c.v. infusion of both MCH and NPY increase food intake above saline but did not affect NEFA concentrations. Previous research has determined that MCH is present in food intake regulatory regions of the sheep hypothalamus and MCH can be altered by physiological states associated with appetite. In this study we found i.c.v. MCH to stimulate food intake in sheep. Hence we propose that MCH qualifies as an endogenous appetite regulator in sheep.

Key Words: Melanin concentrating hormone, Food intake, Sheep

1607 GHRH-receptor is essential to the regulation of GH by GHS in cultured rat pituitary cells. Sang-gun Roh*¹, Chen Chen², Ki-choon Choi¹, Shin-ichi Sasaki¹, and Chang Yoon³, ¹Lab of Animal Molecular Physiology, Faculty of Agriculture, Shinshu University, Naganoken, JAPAN, ²Endocrine Cell Biology Group, Prince Henry's Institute of Medical Research, Melbourne, Australia, ³Dept of Animal Science, Iksan College, Iksan, Korea.

Growth hormone (GH) is secreted in a pulsatile manner from anterior pituitary glands. Secretion of GH is stimulated by GH-releasing hormone (GHRH) and inhibited by somatostatin. The cloning of receptor

for synthetic GH secretagogues (GHS) and the finding of endogenous ligand for GHS-receptor (GHS-R), ghrelin, strongly suggested the presence of another important regulator for the secretion of GH. To address the problem of specificity, we selectively inhibited GHRH-receptor (GHRH-R) and GHS-R gene expression using modified antisense oligonucleotides (ON). We hypothesized that selective inhibition of the GHRH-R and/or GHS-R would disturb the cross talk between GHRH and GHS. To test our hypothesis, we measured the secretion of GH induced by GHS and GHRH challenge (30 min) in cultured male rat pituitary cells in the presence of antisense 18mer phosphorothiate ON targeting on the initiation codon region of GHRH-R and GHS-R mRNA for 3 days. We found a significant decrease in GHRH-R and GHS-R mRNA levels in the corresponding antisense-treated groups compared with the control group and the sense-treated condition. Treatment with GHS-R antisense ON showed the normal GHRH-stimulated GH secretion compared with that in control, lipofectamine and sense-treated cells. In addition, GHRP-2 (peptide GHS)-induced GH secretion was not inhibited by GHS-R antisense ON treatment either. In the cultured cell exposed to the GHRH-R antisense ON, GHRH-stimulated GH secretion was significantly diminished. GHRP-2-induced GH secretion was, however, not affected by such an exposure to the GHRH-R antisense ON. These results indicate a critical importance of GHRH-R for the GH secretion induced by both GHRH and GHS whereas GHS-R is only responsible for the GHS-stimulated GH secretion in cultured rat pituitary cells.

Key Words: Growth hormone, Growth hormone secretagogues, Antisense oligonucleotide

1608 Effect of growth hormone releasing factor (GRF) on long form leptin receptor (Ob-Rl) expression in porcine anterior pituitary. J. Lin^{*1}, C. R. Barb², R. R. Kraeling², and G. B. Rampack¹, ¹University of Georgia, Athens, ²USDA-ARS, Athens, GA.

We previously demonstrated that the Ob-Rl is expressed in the hypothalamus and anterior pituitary of the pig. Moreover, leptin stimulated basal GH secretion, but suppressed the GH response to GRF in pig anterior pituitary cells in culture. Pituitary cells from six pigs, 180 to 200 days of age, were studied in primary culture to determine if GRF affects Ob-Rl expression. On day 4 of culture, 10^5 cells / well were challenged with either 10^{-6} , 10^{-7} or 10^{-8} M [Ala¹⁵]-hGRF-(1-29)NH₂. Secretion of GH into the media and pituitary Ob-Rl mRNA expression were determined at 4 h after treatment. Media were analyzed for GH by RIA and total RNA were isolated from cells for Ob-Rl expression by semi-quantitative RT-PCR. Basal GH secretion was 32 ± 2 ng/mL (n=6 pituitaries). Relative to control at 4 h, 10^{-6} , 10^{-7} and 10^{-8} M GRF increased (P<0.0001) GH secretion by 151%, 129% and 120% and decreased (P<0.05) Ob-Rl expression by 32%, 50% and 38%, respectively. These results indicate that GRF directly modulates Ob-Rl expression at the level of the pituitary and may play a role in regulating pituitary sensitivity to leptin.

Key Words: Pig, Leptin receptor, GRF

1609 Sequence and distribution of a single cDNA encoding growth hormone-releasing hormone-like peptide and pituitary adenylate cyclase activating polypeptide in channel catfish. B. Small* and D. Nonneman, *USDA/ARS Catfish Genetics Research Unit, Stoneville, MS.*

Significant advances have been made in channel catfish nutrition, reproduction and disease research over the past 30 years; however, the mechanisms controlling catfish growth have received little attention. Two neuropeptides which have been implicated in the regulation of fish growth are growth hormone-releasing hormone (GHRH) and pituitary adenylate cyclase activating polypeptide (PACAP). This study reports the sequence and tissue distribution of a single cDNA encoding both GHRH-like peptide (GHRHLP) and PACAP in channel catfish. The GHRHLP/PACAP precursor cDNA was cloned from catfish hypothalamic tissue and a brain cDNA library. Two cDNA variants of the gene were identified as a result of alternative splicing, a long form encoding both GHRHLP and PACAP, and a short form encoding only PACAP. The 110 bp deletion in the short precursor cDNA corresponds to the excision of exon 4, which encodes 71% of the GHRHLP sequence. The complete cDNA sequence was composed of 375 bp of 5-untranslated region containing a polymorphic compound microsatellite (CT-CA). The coding region covered nucleotides 376-900, containing a

signal peptide from 376-435 bp (aa 1-20), GHRHLP from 625-759 bp (aa 84-128) and PACAP from 765-879 bp (aa 130-168). The 3-untranslated region contained a compound microsatellite (GC-GA) beginning within the stop codon. The consensus polyadenylation signal was located from 1058-1063 bp. Catfish PACAP and GHRHLP sequences share 89.5 and 31.1% identity with human PACAP and GHRH, respectively. Catfish GHRHLP is 80% identical to carp native GHRHLP sequence. Both the long and short form of the GHRHLP/PACAP precursor cDNA were identified in catfish brain, pituitary, fat, gastrointestinal tract, muscle, ovary and testes by RT-PCR detection; however, neither variant was detected in gill, heart, kidney, liver, pancreas, skin or spleen. This is the first demonstration of mRNA expression for this gene in fat or skeletal muscle of fish. By characterizing the GHRHLP/PACAP gene and its distribution in channel catfish, we have developed essential tools to investigate the roles of these peptides in the regulation of catfish growth.

Key Words: Channel catfish, GHRH, PACAP

1610 Development of specific antibodies for the quantification of plasma insulin-like growth factor-binding protein-3 in cattle. R. Renaville^{*1}, C. Bertozzi¹, S. Hetzel¹, I. Parmentier¹, S. Fontaine¹, V. Haezebroeck¹, and D. Portetelle¹, ¹Gembloux Agricultural University, Animal and microbial biology unit, Gembloux, Belgium.

Insulin-like growth factor-I and -II (IGF-I, IGF-II) circulate in biological fluids bound to at least six different IGF-binding proteins that regulate IGF bioactivity. The IGF-binding protein-3 is regulated by growth hormone, and its concentration depends on nutrition and physiological state. Unavailable from commercial societies, bovine IGFBP-3 has been previously purified by acid precipitation, molecular filtration and affinity chromatography from pre-colostrum collected 3-5 days before parturition. This preparation has been used to produce specific mouse monoclonal and rabbit polyclonal antibodies and to develop a radioimmunoassay to quantify IGFBP-3 in bovine blood samples. Using the polyclonal antiserum, parallel displacement curves showed strong cross-reactivity with bovine, ovine, rabbit and human plasma protein and no cross-reactivity with porcine, rat, horse, dromedary or chicken plasma. Addition of IGF-I to a control pool of bovine plasma did not significantly alter control IGFBP-3 values in a radioimmunoassay. Nycthemeral periods, determined for three young bulls bled on two occasions were stable throughout the day; two or three samples were sufficient to characterize the animal. Heifers treated with recombinant bovine somatotropin (bST) had significantly higher serum levels of IGFBP-3 than did control animals. Likewise, plasma IGFBP-3 concentrations were decreased in growing bulls treated with clenbuterol (a β -agonist) while these concentrations increased after corticoid (dexamethasone) injection. Furthermore, IGFBP-3 levels were dramatically decreased during the first postpartum weeks. This radioimmunoassay for bovine IGFBP-3, which enables quantitative assessment of IGFBP-3 concentration in cattle, confirmed the previous observations using the less precise Western ligand blotting method. This research was supported by grants of the Belgian Ministry of Small Enterprises, Traders and Agriculture (grant 5736A) and Ministre de la Rgion Wallonne, subvention First Spin-Off (grant 991/3972).

Key Words: IGFBP-3, Cattle, RIA

1611 Responses of Holstein cows to low dose of somatotropin (bST) prepartum and postpartum. M. S. Gulay*, J. Hayden, and H. H. Head, *University of Florida, Gainesville, FL.*

Objectives were to evaluate effects of a low dose of bST injected pre- and postpartum on BCS, BW, MY and IGF-I, INS and metabolites in plasma during experiment carried out during two consecutive years. Holstein cows (194) were assigned randomly to one of two groups [Control (C)=99 vs. Injected (I)=95 cows/group]. Biweekly injections of bST (POSILAC[®]) were prepartum (starting 21 d before expected calving) and through 60 d postpartum (C vs. I; 0 vs. 10.2 mg bST/d). After 60 d, all cows received a full dose of bST. IGF-I, INS, NEFA and glucose were measured in plasma from 82 of the cows (yr1) and BCS and BW of 112 cows (yr2); no blood samples were collected (yr2). MY of all cows were merged and analyzed using mathematical models that included main effects of treatment (bST), calving month, the 2-way interaction, and cow nested in treatment-calving month as error term. bST prepartum resulted in higher mean concentrations of INS (C vs. I; 0.650.037 vs. 0.780.042 ng/ml, P<0.05) and numerically greater NEFA (236.916.4 vs.,

281.616.4 $\mu\text{eq/l}$, $P < 0.13$). bST postpartum did not affect mean concentrations of glucose (66.410.84 vs. 66.740.84 mg/dl) or IGF-I (165.94.5 vs. 168.04.5 ng/ml). Postpartum treatment resulted in increased concentrations of NEFA (331.2 21.2 vs 410.6 20.8 $\mu\text{eq/l}$, $P < 0.02$). No effects of bST treatment were observed on mean concentrations of INS (0.55 0.02 vs. 0.53 0.02 ng/ml), IGF-I (110.57.3 vs. 115.37.1 ng/ml), or glucose (66.131.68 vs. 64.451.65 mg/dl). Mean BCS did not differ prepartum, (3.730.02 vs. 3.760.02) around parturition (3.430.02 vs. 3.520.02), or postpartum (3.240.02 vs. 3.320.02). Although mean BW (kg) did not differ during prepartum (689.25.3 vs. 722.83.3, $P < 0.12$) and around calving (653.43.8 vs. 664.55.1, $P < 0.45$), bST injected group maintained BW better postpartum (618.53.6 vs. 645.83.3, $P < 0.07$). Greater MY was observed for bST-injected group during first 30-d (33.32 vs. 35.95 kg/d, $P < 0.06$), and 60-d (36.92 vs. 39.42 kg/d, $P < 0.07$) of lactation. No difference in MY was observed during the 100-d period (38.09 vs. 39.72 kg/d, $P < 0.22$), which included full dose of bST (60d-100d; 39.72 vs. 40.30 kg/d, $P < 0.70$). No adverse effects of bST treatment were observed during either the pre- or postpartum periods.

Key Words: Transition period, bST, Lactation

1612 Induction of lactation during winter and summer seasons in non-pregnant reproductive cull Holstein cows. M. Chahine^{*1}, W. J. Weber¹, J. K. Reneau¹, B. A. Crooker¹, T. H. Klusmeyer², M. F. McGrath², E. A. Reed², and J. L. Vicini², ¹University of Minnesota, St. Paul, ²Monsanto Animal Agriculture Group, St. Louis, MO.

Effect of season on induction of lactation was assessed with multiparous cows induced in February (FEB, n=15) or June (JUN, n=18). Treatments started on day 0 and consisted of twice daily injections of 17 β -estradiol (0.1 mg/kg BW/d) and progesterone (0.25 mg/kg BW/d) for 7 d, twice daily mammary massage (2-3 min/gland) for the next 6 d, and an injection of dexamethasone (0.05 mg/kg BW/d) on day 13 of study. Cows received POSILAC 1 STEP[®] (500 mg bST) on day 0, 10, 20, and 30 of study and at 14 d intervals thereafter. Milking (3x/d) commenced on day 14 of study and continued for 122 d. Samples from each milking on a single day in weeks 1, 2, 3, 4, 8, 12 and 16 of lactation were collected for analyses. Effect of season was determined using GLM of SAS. Cows were non-responsive and removed if they failed to produce ≥ 9.1 kg of milk on a single day by 24 d of lactation. Induction was successful if at least one daily total milk yield was ≥ 13.6 kg by 50 d of lactation. Two cows failed to respond in each season and one JUN cow responded but was removed for health reasons on day 12 of lactation. Thus, induction was successful in 13 of 15 (86.7%) FEB cows and 15 of 18 (83.3%) JUN cows. Of these cows, one FEB and two JUN cows were removed prior to day 70 of lactation for health reasons. Shape of the lactation curve was similar for both seasons. Total 122 d yields of actual milk (2966, 2729 kg), 3.5% FCM (3077, 2964 kg), and 4.0% SCM (2875, 2722 kg) did not differ between seasons. Daily yield per cow averaged 25.0 kg milk, 27.6 kg FCM, and 25.5 kg SCM. Milk composition did not differ between FEB and JUN cows and averaged 4.2% fat, 3.4% protein, 4.9% lactose and 174×10^3 SCC/ml. In this study, induction was successful in 85% of the cows and milk yield was not affected by season.

Key Words: Induced Lactation, bST, Season

1613 Reduced milk ejection as a consequence of chronic treatment with exogenous oxytocin in cows. R. M. Bruckmaier^{*}, Institute of Physiology, Techn. Univ. Munich-Weihenstephan, Freising, Germany.

Oxytocin (OT), released from the posterior pituitary in response to mechanical teat stimulation, causes myoepithelial contraction and hence alveolar milk ejection during milking. In dairy practice, exogenous OT is often administered before milking for therapy of disturbed milk ejection due to lacking or reduced OT release. The objective of this study was to test the hypothesis that chronic OT administration at each milking causes reduced milk ejection after withdrawal of exogenous OT. Experiments were performed with twenty-one healthy Brown Swiss dairy cows with normal milk ejection during machine milking at 5 a.m. and 4 p.m. One min before the start of each milking cows were injected i.m. either with 50 I.U. of synthetic OT (n = 7; OT-G) or with an equal volume of 0.9 % NaCl (n = 7; NaCl-G) for three weeks. Control animals (n = 7; CO-G) did not receive daily pre-milking injections. At evening milkings on d 0, 7, 14, and 21, no pre-milking injections were performed and residual milk was obtained by i.v. injection of 10 I.U.

OT at the end of milking. In addition, residual milk was obtained at the end of evening milking on d 1, 8, 15 and 22, when each group received a pre-milking injection of 50 I.U. OT i.m. Total milk yield as a sum of spontaneously removed milk (including stripping) and residual milk was set 100 %. On d 0, 952, 903 and 942 % of milk were spontaneously obtained before removal of residual milk in groups OT-G, NaCl-G and CO-G, resp. Spontaneously removed milk was reduced in OT-G on d 7, 14, and 21 ($p < 0.05$) to 825, 816 and 814 %, resp., but was not altered in NaCl-G and CO-G. Pre-milking OT injection on d 1 did not significantly increase the spontaneously removed milk fraction (961, 941 and 971 % in OT-G, NaCl-G and CO-G, resp.). Similar results as on d 1 were obtained on d 8, 15 and 22. In conclusion, chronic OT administration caused a rapid decline of spontaneous milk ejection. Repeated NaCl injection did not reduce milk ejection thus excluding stress effects of the injection procedure. As the response to exogenous OT remained unchanged throughout the experiment, the diminished milk ejection after chronic OT treatment is rather due to reduced OT release than to OT-receptor down regulation.

Key Words: Milk Ejection, Cow, Chronic Oxytocin Treatment

1614 Gene expression of immunologically relevant factors in blood cells, milk cells and mammary tissue of cows. R. M. Bruckmaier^{*}, S. L. Wittmann, H. H. D. Meyer, and M. W. Pfaffl, Institute of Physiology, Techn. Univ. Munich-Weihenstephan, Freising, Germany.

Tumor necrosis factor α (TNF α) and eicosanoids are involved in the mammary gland's immune response. Lactoferrin (Lf) has bacteriostatic effects. The goal of this study was to localize and quantify the synthesis of these factors in milk, blood and mammary tissue cells of cows exhibiting distinct levels of somatic cell counts (SCC) while lacking clinical signs of mastitis. mRNA expression of TNF α , Lf and key enzymes of leukotriene and prostaglandin synthesis, 5-lipoxygenase (5-LO) and cyclooxygenase (COX)-1 and COX-2, resp., was determined in Brown Swiss cows. Control animals (CTR; n=8) had $< 150,000$ cells/ml of milk in all quarters (CQ) while cows with partially elevated SCC (PE; n=7) had minimum one quarter $> 150,000$ (HQ) and one quarter $< 150,000$ cells/ml (LQ). Milk of one CQ of CTR and one HQ and LQ of PE was collected and a blood sample was taken. In addition, mammary tissue samples were obtained from the respective quarters. Total RNA was isolated, reverse transcription and quantitative real-time PCR were performed. TNF α and COX-2 were predominantly expressed in milk cells, 5-LO in blood cells whereas Lf was mainly found in mammary tissue. COX-1 was expressed at similar levels in all cell/tissue types tested. None of the parameters investigated was significantly different between CTR and PE in blood cells (TNF α : 1.00.3 and 0.90.3; COX-1: 0.80.3 and 1.00.3; COX-2: 0.60.2 and 1.91.1; 5-LO: 3.21.7 and 1.00.2; Lf: 0.10.05 and 0.20.1 molecules/cell, resp.). TNF α mRNA expression was elevated in HQ as compared to LQ in mammary tissue (1246 and 277 molecules/mg, resp.; $P < 0.05$). COX-2 mRNA expression was higher in milk cells of HQ than LQ (24.25.8 and 12.94.6 molecules/cell, resp.; $P < 0.05$). 5-LO expression tended to be elevated in milk cells and Lf in mammary tissue of HQ as compared to LQ. No difference was found between CQ and LQ in milk cells and in mammary tissue for any of the parameters tested. In conclusion, the immunological activity of the mammary gland is quarter specific. Besides mammary tissue, somatic milk cells seem to be an important source of factors involved in chemical signalling during immune response.

Key Words: Mammary Gland, Immunology, Chemical Signalling

1615 Effect of intramammary infusion of Escherichia coli endotoxin on ovulation in lactating dairy cows. A. M. Nugent, T. B. Hatler, S. H. Hayes, S. C. Kiggins, and W. J. Silvia^{*}, University of Kentucky, Lexington.

The purpose of this experiment was to determine if intramammary inflammation during the periovulatory period in lactating dairy cows affects the occurrence of ovulation. Ten lactating, cyclic, Holstein dairy cows received 2 injections of prostaglandin F_{2a}, at 11-day intervals, to synchronize luteolysis. The day of the second injection was designated as Day 0. Ovulation was anticipated on days 3-5. Beginning on day 1, cows received intramammary infusions of either Escherichia coli endotoxin (10 ug; n=5) or infusion vehicle (controls; n=5) into 2 quarters immediately after milking. The same quarters were infused after each milking through day 4. Venous blood samples were collected daily

from day -1 through 13 for determination of progesterone to monitor luteolysis and formation of the new corpus luteum. Samples were also collected at 4-h intervals (days -1 to 2), then at 2-h intervals (days 2 to 5) to measure concentrations of luteinizing hormone (LH). Ovaries were examined ultrasonographically on days -1 through 5 and on day 12 to monitor follicular growth and formation of the corpus luteum. Collectively, these observations were used to determine if and when ovulation occurred. Intramammary infusion of *E. coli* endotoxin induced an immediate increase in somatic cell numbers in treated quarters. However, this treatment had no effect on the occurrence or timing of ovulation. Four of 5 cows in each treatment group ovulated. Preovulatory surges of LH were detected within the intensive bleeding periods for 3 cows in each treatment group. The magnitude of the LH surge was reduced in cows receiving endotoxin. Supported by KABA/Select Sires and the KY Agr. Expt. Station.

Key Words: ovulation, luteinizing hormone, endotoxin

1616 Effects of N-nitro-arginine on blood flow and nutrient uptake in the mammary glands of dairy cows. T. G. Madsen^{*1}, D. R. Trout², S. Cieslar³, N. G. Purdie⁴, M. O. Nielsen¹, and J. P. Cant³, ¹*Department of Anatomy and Physiology, The Royal Veterinary and Agricultural University, Denmark*, ³*Department of Animal and Poultry Science, University of Guelph, Canada*, ²*Department of Clinical Studies, University of Guelph, Canada*, ⁴*School of Land and Food Sciences, University of Queensland, Australia*.

Nitric oxide (NO) has been shown to be a potent vasodilator in many tissues and previous research demonstrated that the arginine analogue N-nitro-arginine, which blocks NO synthesis from L-arginine, decreased mammary blood flow (MBF) in dairy goats. The objective of this study was to determine if N-nitro-arginine has the same effect on MBF in dairy cows and, if so, how changes in blood flow affect mammary metabolite uptakes, i.e. arterio-venous (AV) difference multiplied by MBF. Two multiparous Holstein cows in mid-lactation were fed and milked twice daily at 8:00 and 18:00 h. Between morning and evening milking on two consecutive days, saline or a mixture of amino acids (40 g/h) was infused for 9 h into the external iliac artery supplying one udder half. At 15:00 h N-nitro-arginine was added to the infusion at 25 mg/min for 60 min. Blood samples were taken approximately 25 min before and 10, 30, 50, 90 and 140 min after start of N-nitro-arginine infusion for estimation of MBF using the para-amino hippuric acid dilution technique. Blood flow decreased approximately 30 % during infusion of N-nitro-arginine and remained low for at least one hour after the infusion stopped. AV differences for acetate, β -hydroxy butyrate (BHB) and triacylglycerol (TAG) increased when the blood flow dropped; extraction efficiency increased 13, 38 and 14 %, respectively, for these three nutrients. Non-esterified fatty acid AV differences correlated negatively with AV differences of TAG. In conclusion, it is possible to decrease blood flow to the mammary glands of dairy cows by close arterial infusion of a NO synthesis blocker. The mammary glands compensated for the decreased nutrient supply resulting from the lowered blood flow by increasing the efficiency of nutrient extraction from blood.

Key Words: Blood flow, Nitric Oxide, Arginine analogue

1617 Effects of an induced mammogenesis and lactogenesis in sheep on the mRNA expression levels of immune globulin receptors (FcRn; pIGR) and zona occludens proteins (ZO1; ZO2; ZO3). MW Pfaffl^{*}, A Dzidic, P Rojas, RM Bruckmaier, and D Schams, *Institute of Physiology, Technical University of Munich, Freising-Weihenstephan, Germany*.

Mammary immune response is mediated mainly through phagocytotic leucocytes but to some extent by secreted immune globulins A (IGA) and G (IGG). Tight junction (TJ) barrier, built by zona occludens proteins 1-3 (ZO1-3), limit the movement of immunoactive leucocytes from the blood circulation into milk. During pregnancy TJs are leaky, undergoing a closure shortly before parturition to remain impermeable during lactation. IGG and IGA are transported transcellularly into secretion by IGG receptor (FcRn) and polymeric IG receptor (pIGR), respectively. Influence of steroids, dexamethason (DEX) and prolactin (PRL), to induce mammogenesis (MG) and lactogenesis (LG), and effects on the expression profile were investigated in sheep. MG was induced by a frequent estrogen and progesterone treatment (day 1-29), and LG via DEX and manual stimulation (day 30-37). In one group PRL secretion was inhibited by bromocriptin (BR+, n=4) and compared with

BR- (n=4) and a non treated control (K, n=4). Sheep were slaughtered (day 38) and mammary tissue was sampled for RNA extraction. Expression studies were done in real-time RT-PCR and each sample was normalised to internal ubiquitin expression. Relative expression levels of BR+ and BR- were compared with the control group (K=1). MG and LG could be induced and histology showed an alveolar development in BR- higher than in BR+, and a white secret could be retrieved by hand milking with physiological concentrations of fat, protein, lactose and somatic cells. PRL concentrations were successfully suppressed in BR+. Expression data showed no significant changes in pIGR, ZO1 and ZO3. FcRn and ZO2 expression were significantly elevated in BR+ and BR-. Only a trend of higher pIGR and ZO3 expression could be shown in BR- compared to BR+. In conclusion, the PRL inhibition and desired blockage of LG through BR had no effects in sheep. FcRn and ZO2 concentrations could be up-regulated, influenced by steroids and DEX, resulting in a higher IGG concentration in colostrum milk and impermeable TJ. No effects of BR treatment could be observed.

	FcRn	pIGR	ZO1	ZO2	ZO3
BR-	3.40±2.97 p=0.02	2.57±2.50 p=0.07	1.04±0.31 p=0.74	2.42±0.40 p≤0.001	2.17±1.45 p=0.07
BR+	4.27±3.28 p=0.008	1.11±0.81 p=0.67	1.03±0.27 p=0.73	2.02±0.21 p≤0.001	1.70±1.10 p=0.14
K	1	1	1	1	1

Key Words: Induced Mammogenesis and Lactogenesis, IG receptors, Zona occludens proteins, Relative expression in real-time RT-PCR

1618 Effect of chromium-methionine level supplementation on immune response of bull calves recently arrived to feedlot. L. Almeida^{*1} and R. Barajas¹, ¹*FMVZ-Universidad Autonoma de Sinaloa*.

To determinate the effect of chromium-methionine level supplementation on immune response of calves recently arrived to feedlot, twenty bull calves (7/8 Brahman; 167 kg) were used in a 28 days complete randomized design experiment. After 300 km truck transportation the animals were randomized assigned (five by treatment) to receive one of four diets in that consist the treatments: 1)Diet 30:70 roughage:concentrate with 15% CP and 1.4 Mcal NEm/kg (control); 2)Diet similar to control, but supplemented with 0.4 ppm of chromium from chromium-methionine (Cr-Met; MicroplexTM, Zinpro, CO); 3)Diet supplemented with 0.7 ppm of Cr from Cr-Met; and 4)Diet supplemented with 1.0 ppm of Cr from Cr-Met. The animals were allocated in ground pens with central shade, fed twice a day with permanent access to fresh tap water. Next day to arrived, animals were dewormed, vaccinated again IBR, PI3, BRV,BVD, Clostridium, and Pasteurella; weighed, tagged, and ear hormone implanted. Blood samples were taken from jugular vein at start the experiment, and in days 7, 14 and 28. Cortisol, creatinin, glucose, globulin G, globulin M, and aspartate aminotransferase enzyme were determinate. After seven days, chromium supplementation tended (P<0.09) to diminished in 60% blood cortisol concentration (3.6 vs. 1.4 μ g/dL), and at 14 days 1.0 ppm of Cr reduce (P<0.04) cortisol (2.8 vs. 0.2 μ g/dL). Chromium 1.0 ppm increased (P<0.03) immunoglobulin G levels in days 14 and 28. Immunoglobulin M tended (P<0.14) to be increased by 1.0 ppm Cr supplement. Addition of 0.7 and 1.0 ppm of chromium tended (p<0.07) to increase glucose level in day 28. Aspartate aminotransferase enzyme concentrations tended to decrease (P<0.07) in day 7 with 1.0 ppm Cr treatment. Creatinin was not affected (P>0.20) by treatments. It is concluded that chromium-methionine supplementation improve the immune status of bull calves recently arrived to feedlot and that 1 ppm of Cr appears to be eligible level.

Key Words: Chromium, Supplementation, Bull calves

1619 The effect of equi-molar dietary betaine and choline additions on liver, plasma and gut of pig. K. Tiihonen^{*1}, S. Peuranen¹, H. Siljander-Rasi², and H.P. Simmins³, ¹*Danisco Cultor Innovation Center, Kantvik, Finland*, ²*Agricultural Research Centre of Finland, Hyvink, Finland*, ³*Finnfeeds International Ltd., Marlborough, Wilts, UK*.

The mode of action of dietary betaine and choline in pigs were studied. In broiler chicks dietary betaine is twice as efficient as equi-molar dietary

choline for increasing liver betaine levels but in pigs that has not been studied previously. Individually penned Finnish Landrace and Yorkshire pigs (30 kg; n=70) were fed basal diet with no added betaine or choline, the basal diet supplemented with 250, 500 or 1000 mg/kg of betaine (Betafin® S1), or with a similar molar amount of choline (578, 1155 or 2310 mg/kg of choline chloride). The net energy content of the maize-soybean meal basal diet was diluted with oat hull meal (100 g/kg) and it contained 8.55 MJ/kg NE, 155 g/kg crude protein and 7.4, 4.4 and 4.3 g/kg digestible lysine, threonine and methionine+cystine, respectively. The pigs were on restricted diet, 1.5-3.0 kg feed/d. The experiment lasted 75 days. Daily weight gain improved linearly ($p \leq 0.01$) with increasing dietary betaine. The liver betaine level increased linearly with dietary betaine addition ($p \leq 0.05$). The additives had no significant effect ($p \geq 0.10$) on plasma homocysteine levels. Addition of betaine tended to improve the tensile strength of the proximal ileum linearly ($p = 0.07$). Choline additions increased plasma carnitine linearly ($p \leq 0.01$) but had no effect on the pig performance, liver betaine or gut tensile strength. The results show that dietary betaine addition increased liver betaine and improved the daily weight gain of pigs on restricted diets with diluted energy concentration whereas choline addition increased plasma carnitine but had no effect on performance.

Betaine, mg/kg	0	250	500	1000	0	0	0	
Choline chloride, mg/kg	0	0	0	0	578	1155	2310	SEM
Daily weight gain, g	883	879	943	969	897	909	906	22.2
Liver betaine, mg/g	0.038	0.041	0.051	0.061	0.037	0.044	0.042	0.007
Plasma carnitine, mg/l	1.26	1.39	1.41	1.30	1.31	1.37	2.80	0.20
Gut tensile strength, kg	2.10	2.44	2.14	2.80	2.41	2.52	2.16	0.26

Key Words: Betaine, Choline, Pig

PSA Physiology: Cardiopulmonary, Immune, and Other Physiology

1620 Differences of autonomic nervous system activity in high and low body weight-selected chickens. A. Y. Kuo^{*1}, J. C. Lee², P. B. Siegel¹, and D. M. Denbow¹, ¹Virginia Tech, Blacksburg, ²VA-MD Regional Veterinary College, Blacksburg.

This study was to investigate whether there are differences in the autonomic nervous system (ANS) function of chickens from lines selected or high (HWS) or low body-weight (LWS). The cardiovascular response to pharmacological agents was used as an indicator of ANS response. Ten birds from each line and sex were used. Catheters were introduced into the left brachial artery and vein, and connected to a MP100-BIOPAC system to record blood pressure (BP) and heart rate (HR). Birds were injected with phenylephrine, atropine, propranolol, and tetraethylammonium chloride (TEAC). Data were analyzed using ANOVA; significant differences imply $P \leq .05$. The LWS birds exhibited a greater increase in BP and less increase in HR than the HWS birds following atropine. The response to atropine showed a line and sex interaction, in which male birds had a greater increase in HR than females, and LWS females had a lower increase in HR than the HWS females. Injection of phenylephrine following pretreatment with atropine caused a baroreceptor reflex in which males showed a greater decrease in HR than females. In response to the beta-adrenergic receptor blocker propranolol, females displayed a greater decrease in BP than males, and LWS birds had a greater decrease in HR than HWS birds. In response to the autonomic ganglionic blocker TEAC, BP and HR were decreased equally in both lines. The percentage of adrenal and sympathetic impact on regulation of HR showed that LWS females required greater adrenal activity than the other birds. While change in the HR to BP ratio in response to phenylephrine was different between lines, the response was not different when phenylephrine was given following atropine. These results suggest that a higher parasympathetic nervous system tone is present in the HWS, and a higher sympathetic nervous system tone is present in the LWS than HWS birds. It is suggested that differences between the lines could be at the level of the adrenal gland.

Key Words: Autonomic nervous system, Blood pressure, Chickens

1621 Hemodynamic Responses of Broiler Pulmonary Vasculature to Intravenously Infused Serotonin. M. E. Chapman* and R. F. Wideman, University of Arkansas, Fayetteville, AR, USA.

Serotonin (5-hydroxytryptamine, 5HT) is a potent pulmonary vasoconstrictor actively accumulated by mammalian platelets and avian thrombocytes, and released into the plasma during platelet or thrombocyte aggregation. 5HT has been implicated in the mechanisms responsible for pulmonary hypertension in several human and animal studies. However, the role of 5HT in pulmonary hypertension syndrome (PHS, ascites) in broilers previously had not been evaluated. In the present study we evaluated the pulmonary hemodynamic responses of broilers to intravenous infusions of 5HT dissolved in 2.5% mannitol solution (carrier vehicle).

Carrier vehicle infusion alone had no influence on any of the hemodynamic variables. 5HT infusion triggered rapid increases in pulmonary arterial pressure to approximately 50% above pre-infusion baseline values, accompanied by decreases in mean systemic arterial pressure and cardiac output. The peak pulmonary arterial pressure response occurred within approximately 70 s after the start of 5HT infusion, and remained elevated above baseline values over the course of a 10-minute infusion period. Pulmonary arterial pressure, mean systemic arterial pressure and cardiac output returned to pre-infusion baseline values upon cessation of 5HT infusion. Pulmonary hypertensive responses were associated with increased pulmonary vascular resistance (pulmonary vasoconstriction). The peak pulmonary arterial pressure attainable was inadequate to propel the normal cardiac output through the elevated pulmonary vascular resistance. Consequently, the impeded venous return to the left ventricle caused dependant reductions in stroke volume, cardiac output, and mean systemic arterial pressure. Reductions in cardiac output were associated with reductions in stroke volume but not heart rate. Any factor that reduces the pulmonary vascular capacity or increases the pulmonary vascular resistance theoretically can increase the incidence of PHS. The present study provides direct evidence that 5HT can trigger pulmonary vasoconstriction and pulmonary hypertension in broilers.

Key Words: Serotonin, Broiler, Hypertension

1622 Pulmonary Wedge Pressures Confirm Pulmonary Hypertension in Broilers is Initiated by an Excessive Pulmonary Arterial Resistance. M. E. Chapman* and R. F. Wideman, University of Arkansas, Fayetteville, AR, USA..

High retrograde pressure through the pulmonary venous system caused by failure of the left ventricle or left atrio-ventricular valve may result in the elevated pulmonary arterial pressure and right ventricular hypertrophy associated with pulmonary hypertension syndrome (PHS; ascites) in broilers. Unanaesthetized male broilers from an ascites-resistant line, the base population from which the resistant line was derived, and a separate unselected line were used to determine whether changes in wedge pressure are predictive of differences in the pulmonary arterial pressure of clinically healthy and pre-ascitic broilers. Venous, right atrial, right ventricular, pulmonary arterial, and wedge pressures were obtained by inserting a catheter into a wing vein and progressively advancing the catheter into a pulmonary branch artery until the catheter tip became wedged in and occluded the flow through a terminal artery. Mean right ventricular and pulmonary arterial pressures were lower in the resistant line than in the base population, but wedge pressures did not differ between the resistant, base, and unselected lines. Right:total ventricular weight ratios (RV:TV) and the percentage saturation of hemoglobin with oxygen in arterial blood ranged in value from 0.18 to 0.44 and 65 to 96%, respectively. Wedge pressure, however, remained similar when pre-ascitic broilers with high RV:TV values and low oximetry values were compared with clinically healthy broilers. In all birds, whether healthy or showing pre-ascitic characteristics, the wedge pressure was slightly

higher than the right atrial pressure, but substantially lower than pulmonary arterial pressure. These observations provide definitive proof that pulmonary hypertension is initiated as a consequence of excessive pulmonary arterial or arteriole resistance. Pulmonary venous pressure is estimated by measuring the pulmonary arterial wedge pressure, and high wedge pressures would be evident if pulmonary hypertension was caused by the elevated downstream resistances associated with left-sided heart failure.

Key Words: Ascites, Wedge Pressure, Broiler

1623 Cardiopulmonary and blood gas responses to cold exposure in broiler chickens. T.W. Odom*¹, M.A. Thompson¹, K.P. Floren¹, G.A. Ramirez¹, N. Puebla-Osorio¹, L.A. Martinez-Lemus², and J.S. Thomas³, ¹Department of Poultry Science, Texas Agricultural Experiment Station, ²Departments of Medical Physiology, ³Veterinary Pathobiology, Texas A&M University, College Station, TX 77483.

Cold exposure is a well-established cause of the development of pulmonary hypertension syndrome (PHS) in broiler chickens. Therefore, in this study we used cold exposure to induce PHS. Subsequently we measured venous blood acid-base balance and several cardiopulmonary parameters. Forty 1-day-old male broiler chickens, were equally divided in 2 environmental chambers and maintained at 25 C for one week. The temperature was not changed in one environmental chamber and the other environmental chamber was changed by a gradual step-down program until the chamber reached to 10 C and maintained at that point for an additional 3 weeks. Body weight (BW), heart rate (HR), right ventricular hypertrophy, venous blood gases, and plasma thrombin-antithrombin (TAT) complexes (a sensitive indicator of *in vivo* activation of the clotting cascade) were measured. Broiler chickens in the 10 C chamber had significantly ($P \leq 0.05$) reduced BW and HR, increased total venous CO₂ and HCO₃⁻, increased right ventricular hypertrophy, and increased plasma TAT complexes compared with the broiler chickens in 25 C chamber. This study suggests that cold exposure for 3 weeks results in an altered acid-base balance in the blood, a hypercoagulable state, and a cardiovascular dysfunctional circulation. Consequently, these results support that cold exposure produces stress on the cardiopulmonary system predisposing the broiler chicken to develop PHS.

Key Words: Broiler, Cold Stress, Blood Gas

1624 Thrombocyte aggregation does not correspond with nitric oxide and cardiovascular parameters in broiler chickens with pulmonary hypertension. A.R. Carpenter¹, L.A. Martinez-Lemus², J.S. Thomas³, and T.W. Odom*¹, ¹Department of Poultry Science, Texas Agricultural Experiment Station, ²Departments of Medical Physiology, ³Veterinary Pathobiology, Texas A&M University, College Station, TX 77843.

Pulmonary hypertension syndrome (PHS) is a multifactorial disease that affects predominantly the fast-growing broiler chicken. Research in mammalian models has suggested that platelet activity, thrombosis, and reduced synthesis of nitric oxide (NO) may be involved in pulmonary hypertension. Therefore, this study was designed to investigate the relationship thrombocyte aggregation may have with NO, and other cardiovascular parameters in PHS. Broilers were reared either under hypobaric conditions (HC) to induce PHS or under normobaric conditions (NC) for five weeks. Aggregation was measured in both whole blood and in thrombocyte-rich plasma. Whole blood aggregation was measured in order to assess thrombocyte function in a milieu similar to that *in vivo*. Thrombocyte-rich plasma provided an environment, which allowed for a more clear representation of thrombocyte activity unaltered by other blood cells. Body weights and cardiovascular parameters were compared in both experiments, and NO produced by a right pulmonary artery ring was measured. Compared with NC broilers, HC broilers had increased hematocrit levels, right ventricular hypertrophy, and PHS mortality. Right pulmonary artery rings from HC broilers also produced significantly less NO than NC broilers at 4 weeks of age. There were no consistent differences in thrombocyte aggregation between the NC and HC broilers. Also, thrombocyte aggregation did not correspond with

NO production by the right pulmonary artery ring or with PHS mortality. Thus, changes in thrombocyte aggregation may not be related with PHS in the broiler chickens.

Key Words: Broiler, Aggregation, Nitric Oxide

1625 Assessment of factor V, VII, and X activity, the key coagulant proteins of the tissue factor pathway in poultry plasma. A.E. Thomson*, E.J. Squires, and P.A. Gentry, University of Guelph, Guelph Ontario Canada.

Assay methods were developed for key components of the tissue factor pathway of coagulation, namely Factor V, Factor VII and Factor X. Using these assays, plasma from healthy laying hens, roosters and broilers was shown to contain functional and equivalent amounts of each of these clotting factors. The plasma activity for Factor V, Factor VII, and Factor X can only be accurately determined when chicken tissue factor is used to initiate the coagulation mechanism in poultry plasma. Neither human tissue factor nor rabbit tissue factor forms a fully functional enzyme reactive complex with chicken Factor VII. The overall Tissue Factor Pathway coagulation mechanism was evaluated in plasma from laying hens, roosters and broilers using the One-stage Prothrombin Time assay. As long a sufficient tissue factor was used, the overall clotting time results obtained with human recombinant tissue factor were not significantly different ($P > 0.05$) from those obtained with chicken tissue factor. We conclude that poultry plasma does possess a fully functional tissue factor coagulation mechanism, but homologous chicken tissue factor must be used for *in vitro* assays of the components of this pathway.

Key Words: Tissue Factor Pathway, Coagulant Proteins, One-Stage Prothrombin Time

1626 Establishing endocrine and behavioral indices for endocrine-disrupting chemicals in birds. M.A. Abdelnabi*, N. Thompson, and M.A. Ottinger, University of Maryland, College Park, MD USA.

Endocrine-disrupting chemicals (EDCs) would be expected to affect growth and reproduction. Japanese quail provide an avian model to establish endocrine and behavioral indices for EDC exposure. In these experiments, fertile eggs from the parents (P1) were injected at embryonic day 11 (E11) with estradiol benzoate (EB; 20 ug/egg), oil control (con), or uninjected. Chicks (F1) were raised to maturity and housed in pairs with all possible crosses (EB x con; EB x EB; and con x con) to assess fertility and productivity. A separate subset of EB and control F1 males were photoregressed, then implanted with testosterone and tested for sexual behavior one week later. In addition, eggs were collected from EB and control F1 pairs, then incubated. At embryonic day 11, eggs from the EB pairs were divided into two groups; the first was injected with EB (F2a) while the rest of the eggs from the EB pairs were not treated (F2b) the eggs from control pairs were not treated (F2c). After hatch, chicks (F2) were raised exactly as F1 chicks had been raised. F1 males were demasculinized by the EB treatment and when paired with EB females, fertility was severely reduced (35% vs 85%). F1 females showed erratic egg production (55% vs 90%). F2 birds that were embryonically treated with EB (F2a) also showed reproductive impairment, similar to that observed in the EB treated F1s. Fertility and productivity were 90 and 83%; 86 and 72% and 57 and 32% for the control, non-injected and EB injected, respectively. Interestingly, there appeared to be a carry over effect in the F2 offspring. This study provides evidence for long-term consequences of embryonic estrogen exposure to estrogen and suggests that these measures are potential indices for EDC exposure. Supported by EPA #R826134010 (MAO) and NSF #IBN-9817024 (MAO).

Key Words: endocrine disrupting chemicals, embryonic development, sexual differentiation

1627 Immunological effects of genistein exposure in chicks. Alexander Peterson¹, Haitao Li¹, and Wallace Berry*¹, ¹Auburn University Department of Poultry Science.

Exposure of chicks to high levels of sex steroids causes involution of the thymus and bursa with subsequent impairment of immune function.

Domestic poultry are exposed from hatching onward to potentially estrogenic isoflavones in soy based diets. Our previous work has demonstrated that the soy isoflavone genistein is estrogenic in chickens. The purpose of this study was to determine whether genistein would exert effects on thymus and bursa in a manner similar to that of estrogen and testosterone. Day old male chicks were assigned to 6 treatments as follows: chicks fed a typical soy based chick diet with daily subcutaneous injection of sesame oil vehicle (SV); soy-free diet and vehicle injection (V); daily injection of 0.5 mg diethylstilbestrol as a positive control (DES); 0.5 mg testosterone propionate as a positive control (TP); 1.0 mg genistein injection (G1); and 10.0 mg genistein (G 10). At 12 days of age, the chicks were weighed and testes and livers were excised and weighed. DES treatment significantly decreased bursa and thymus weight and increased liver weight. TP also decreased bursa and thymus weight and increased liver and testes weight. G 10 treatment significantly reduced both bursa and thymus weight and increased liver weight. These results demonstrate that genistein has effects similar to the sex steroids on immune tissues in chickens and may influence immunological development in poultry species. (Supported by the Alabama Agricultural Experiment Station and USDA AD-421 project S-289).

Key Words: Genistein, Thymus, Bursa

1628 Partial structural characterization of Bursal Anti-Steroidogenic Peptide (BASP) with structural homology to chicken histone H1. R.W. Moore^{1,2}, D.Y. Caldwell², T.E. Porter³, L.R. Berghman², F. Vandesande⁴, J.A. Byrd¹, and B.M. Hargis⁵, ¹USDA-ARS-SPARC, ²Texas A&M University, ³University of Maryland, ⁴University of Leuven, Belgium, ⁵University of Arkansas.

Previously, our laboratory has described a bursa of Fabricius-derived molecule that was named Bursal Anti-Steroidogenic Peptide (BASP) after its potent anti-steroidogenic activity. While the biological activity of BASP in several *in vitro* systems has been studied in our laboratory, until recently, molecular/structural characterization has remained elusive due to lack of substantial amounts of highly purified biologically active material useful for conventional sequencing. Presently, endopeptidase digestion, fragment purification, and conventional N-terminus sequencing of each of the two predominant bands (24 and 30 kDa) from SDS PAGE of highly purified biologically-active BASP were performed and six low level sequences were determined. Each of these short fragment sequences showed homology with the known sequence of chicken histone H1. A single partial sequence homologous with the structure of chicken histone H1 was also obtained utilizing Q-TOF analysis. In addition, a unidirectional cDNA library constructed from bursa of Fabricius mRNA was screened with polyclonal antibody probes constructed against highly purified biologically active BASP. Six expression proteins were identified, and nucleotide sequencing of the lambda phage inserts revealed 4 unique partial nucleotide sequences from the 6 sequenced cDNA inserts. One of these nucleotide sequences (two overlapping cDNA inserts) was 99% homologous with chicken histone H1. These observations may argue that BASP is either identical to, processed from, or shares homology with chicken histone H1. Purification of chicken histone H1 for bioassay has been initiated.

Key Words: Bursal Anti-Steroidogenic Peptide, Histone H1, Bursa of Fabricius

1629 Influence of broiler breeders age on villous and microvillous height in the embryo intestinal mucosa. Alex Maiorka¹, A.V. Fischer da Silva¹, E. Santin¹, L.O. Nakagui¹, and M. Macari¹, ¹FCAV - UNESP.

This study was carried out aiming to evaluate the effect of broiler breeders age (30 or 60 week) on embryo intestinal mucosa development. At 20th day of incubation, 8 embryos of each broiler breeder age were sacrificed and sample from different parts of the small intestine were collected (duodenum, jejunum and ileum) and submitted to morphometric studies under light microscopy using an image analysis system. The parameters studied were villous height (micrometer), crypt depth (micrometer) and microvillous height (micrometer) using transmission electron microscopy. The experimental design was completely randomized with two treatments and eight repetitions, with the data submitted to analysis of variance. At light microscopy analysis it was observed that intestinal mucosa of embryos from 30-wk broiler breeders showed smaller villous height when compared to those from 60-wk broiler breeders (77 vs 102; 40 vs 45 and 31 vs 41 for duodenum, jejunum and ileum, respectively)

and smaller crypt depth (44 vs 53 ; 31 vs 37 and 26 vs 31 for duodenum, jejunum and ileum, respectively). The results of the transmission electron microscopy analysis showed that the embryo from 30-wk broiler breeders had smaller jejunum microvillous height than that verified in jejunum of embryos from 60-wk broiler breeders (0.874 vs 1.090). These results indicate that broiler breeder age has an important role on intestinal mucosa embryo development. FAPESP Proc.98/11304-9

Key Words: Embryo, Intestinal mucosa development, Age of broiler breeders

1630 Effect of feed and/or water withdrawal on intestinal mucosa development in broiler chicks after hatching. Alex Maiorka¹, Elizabeth Santin¹, Fabiano Dahlke¹, and Marcos Macari¹, ¹FCAV-UNESP.

This study aimed to evaluate the effect of feed and/or water withdrawal on intestinal mucosa development in broiler chicks after hatching. In Trial I, 20 day-old broiler chicks, male, were used. After hatching, the birds were maintained in environmentally controlled room and divided in two groups and fed as follows: T1- water and feed ad libitum; T2 - water ad libitum and no feed. After 24 h of hatching samples from different segments of the small intestine were collected (duodenum, jejunum and ileum) which were submitted to morphometric studies using light microscopy using an image analysis system. The parameters studied were: villous weight and crypt depth. The results did not show difference between treatments in duodenum (P=0.434), jejunum (P = 0.699) and ileum (P = 0.060) for villous height and crypt depth in the duodenum (P = 0.434), jejunum (P = 0.825) and ileum (P = 0.246). In Trial II, 72 day-old broiler chicks, male, were divided into 4 treatments and fed as follows: T1- water and feed ad libitum; T2 -water ad libitum and no feed; T3 - no water and feed ad libitum and, T4 - no water and no feed. After 24, 48 and 72 hours post-hatching, 6 birds of each treatment were sacrificed and sampled from different parts of the intestine were collected (duodenum, jejunum and ileum) and submitted to scanning electron microscope studies to evaluate the villous density. The chicks fasted of feed and/or water showed greater number of the villous/area in all intestine mucosa segments, irrespective of the fasting period, than those in the birds not fasted. The results of this study suggest that not only feed is relevant to villous development in the mucosa of broiler chicks after hatching, but water, as nutrient, also play a important role in this mechanism. The findings also revealed that 24 h fasting is deleterious to intestine mucosa integrity. FAPESP Proc. 98/11304-9.

Key Words: fasted, intestinal mucosa development, post hatching

1631 Expression of selected hepatic genes related to lipid metabolism in broiler breeders. M.P. Richards¹, S.M. Poch¹, C.N. Coon², Y. Kirby², R.W. Rosebrough¹, C.M. Ashwell¹, and J.P. McMurtry¹, ¹USDA, ARS, Beltsville, MD, ²University of Arkansas, Fayetteville, AR.

Cobb 500 broiler breeder pullets were fed according to Cobb Breeder Management Guide specifications until they reached 21 weeks of age. At this time, half the birds were switched to *ad libitum* feeding (AL) while the remaining birds continued to be fed according to Cobb guidelines (CF). At 22 weeks all birds were photostimulated and maintained throughout a laying cycle ending at 36 weeks. Samples of liver and abdominal fat pad were collected at the following times: 1) just prior to photostimulation, 2) after photostimulation through first egg, and 3) at peak egg production. Reverse transcription polymerase chain reaction in conjunction with capillary electrophoresis and laser-induced fluorescence detection (RT-PCR/CE-LIF) was used to quantify hepatic expression of specific genes relative to that of β -actin in total RNA samples. Expression of fatty acid synthase (FAS), malic enzyme (ME), and acetyl-CoA carboxylase (ACC) genes in AL hens declined from their highest levels just prior to photostimulation to reduced levels as the birds came into and maintained egg production. In contrast, the CF hens displayed a dramatic increase in the expression of these genes following photostimulation through first egg with a subsequent decline in expression levels as these birds reached peak egg production. Expression of fatty acid binding protein (FABP) and apolipoprotein B (ApoB) genes increased in both AL and CF breeders following photostimulation. This is consistent with increased hepatic lipid transfer capacity during egg production. Abdominal fat pad weights were significantly higher in the AL as compared to CF hens following photostimulation.

Hepatic leptin receptor gene expression did not differ significantly for AL as compared to CF hens at any time. In conclusion, the AL and CF feeding regimes produced significantly different effects on hepatic gene expression related to lipid metabolism in broiler breeders. By analyzing the expression of specific hepatic genes involved in lipogenesis and lipid transport as well as other metabolic pathways, it may be possible to assess the potential metabolic impact of changes in feed consumption and other management practices on growth, body composition and performance of broiler breeders.

Key Words: Gene Expression, Lipid Metabolism, Broiler Breeder

1632 Identification and expression of the turkey leptin receptor gene. M. P. Richards*, S. M. Poch, and C. M. Ashwell, *USDA, ARS, Beltsville, MD.*

Using reverse transcription polymerase chain reaction (RT-PCR) with total RNA isolated from whole brain tissue, we have sequenced 3976 bases of the turkey leptin receptor (Ob-R) gene corresponding to the complete coding sequence and portions of the 5'- and 3'-untranslated regions of the mRNA (GenBank accession no. AF321982). Turkey Ob-R showed greater than 90% sequence identity at both the nucleic acid and amino acid level with chicken Ob-R (GenBank accession nos. AB033383 and AF169827). The turkey Ob-R gene (long form) codes for a protein comprised of 1147 amino acids that displays a number of features similar to other leptin receptors including a signal peptide, a single trans-membrane domain and specific conserved motifs defining putative leptin binding and signal transduction regions of the protein. RT-PCR in conjunction with capillary electrophoresis and laser-induced fluorescence detection was used to quantify Ob-R expression relative to that of β -actin in total RNA samples isolated from various tissues. Ob-R expression was highest in brain, spleen and lung tissue obtained from 3 wk old poults with lower levels of expression in kidney, pancreas, duodenum, liver, fat, and breast muscle. Using a primer set specific for the long form of OB-R (Ob-RL), the highest levels of expression for this variant form were detected in brain, lung and spleen with lower levels in kidney, pancreas, fat and liver tissues. Ob-R expression in developing turkey embryos was highest in brain tissues and remained high throughout incubation (days 14-28). In contrast, expression of Ob-R in embryonic liver tissue peaked at day 16 and then declined toward hatching (day 28). Yolk sac expression of Ob-R declined from day 14 to day 20 and then increased toward hatching. These findings suggest differential regulation of Ob-R expression in turkeys during embryonic and post-hatch development. In conclusion, this is the first report of leptin receptor gene expression in turkeys.

Key Words: Leptin Receptor, Gene Expression, Turkey

1633 *Campylobacter* colonization of the crops of newly hatched chicks. R. L. Ziprin* and L. F. Kubena, *FFSRU/SPARC/ARS/USDA, College Station, TX/USA.*

It has been reported that up to sixty percent of the crops of market age birds contain *Campylobacter*. However, this number may not represent true colonization but only transient presence of the organism. In our present work we have studied colonization of crops in newly hatched chicks by wild-type and mutant strains of *C. jejuni*. Groups of 15 day-of-hatch Leghorn chicks were orally gavaged with 10^8 CFUs of the wild-type strain on day-of-hatch or with an equivalent number of mutant *C. jejuni*, which had been previously shown to be ineffective colonizers of the cecum. Three birds from each challenged group were killed by cervical dislocation on days 1,3,5,7, and 9 after inoculation. There was a 2-4 hour feed withdrawal period before sacrifice. Crops were aseptically removed, placed in individual plastic bags containing 5 ml of sterile water, and placed in a Stomacher device. The *C. jejuni* concentration in the resultant suspension was determined by standard plate count methods, using Campy-Cefex agar. We observed an initial rapid drop in *Campylobacter* concentrations present in the crop during the first 24 hrs after challenge, then a stable concentration of approximately 10^5 CFUs was established through days 7 to 9. Mutant strains lacking an ability to colonize cecum were found to persist in the crop. Concentrations of these mutant strains in the crop were usually below that of the wild-type, but were still between 10^3 to 10^5 CFUs. These results indicate that the bacterial factors necessary for colonization of the crop are not the same as those needed for colonization of the cecum.

Key Words: *Campylobacter*, Crop, Colonization

1634 Heterogeneity of Ryanodine Receptors in Turkeys. Wen Chiang* and Gale Strasburg, *Michigan State University.*

Pale, soft, exudative (PSE) meat has been a serious quality problem in the turkey industry. Because of the striking similarity of development of PSE turkey to that of PSE pork, there could be a genetic basis for some of the incidence of PSE turkey. A point mutation (R615C) in the SR calcium channel protein or ryanodine receptor (RYR1) is associated with porcine malignant hyperthermia, and results in economic losses to producers from animal death by stress, and to processors by abnormalities in meat quality resulting from rapid postmortem glycolysis. Over 20 mutations in the primary structure of mammalian RYR1 have been associated with Malignant Hyperthermia (MH) and Central Core Disease (CCD) in human. At least 9 of these mutations cluster in the region of amino acid residues 35 to 614. We hypothesized that one or more mutations exist in the region of the turkey alpha-RYR (homologous to mammalian RYR1) which give rise to this problem. RNA was purified from genetically unimproved turkeys and from a commercial line intensively selected for muscle growth. alpha-RYR cDNA was amplified through RT-PCR and was cloned into a plasmid vector. Analysis of the alpha-RYR cDNA covering amino acids 376 to 647 (human sequence) reveals sequence diversity in the unimproved turkey population. One group is homologous to the commercial line and to mammalian RYR sequences. Another unimproved group shows a 27 amino-acid-residue deletion (residue numbers: 417-443). Another unimproved group shows heterogeneity of cDNA variants. The variants are characterized by the presence or absence of 81 bp, 193 bp, and 329 bp sequences. The exclusion of the 81 bp sequence results in the absence of amino acids corresponding to Ser-416 to Ser-443. The exclusion of the 193 and 329 bp sequences leads to frame shifts that introduce internal stop codons. Avian muscle fibers also express an additional RYR isoform, beta-RYR, which is homologous to the mammalian non-muscle isoform. Our ryanodine binding studies indicate that there is functional diversity of beta isoforms within the commercial turkey population. These results suggest that mutations may exist in either isoform or in both, which could predispose turkeys to yielding of PSE meat.

Key Words: Meat Quality, Ryanodine Receptor, PSE Meat

1635 Intestinal calcium uptake and reproductive hormones in three laying hen varieties after prolonged egg production. D. J. Franco*, K. K. Franzen¹, C. F. Toombs¹, and M. M. Beck¹, ¹*University of Nebraska.*

Hy-Line W-98, W-36, and Brown hens are among the most popular strains for commercial egg production around the world. Although hens of all three types lay approximately the same number of eggs/hen housed to 80 weeks, fewer eggs and more soft shelled or broken shell eggs are observed during prolonged egg production. Also, the increase in egg size with age brings, as a result, an insufficient calcium carbonate secretion, and consequently the thickness of the eggshell declines (R.J. Etches, 1996). As part of a larger study, hens of the three varieties were maintained under production longer than 100 weeks and hens of each strain were randomly selected for in vitro determination of calcium uptake (CaT) by duodenal cells. Blood samples were collected 4-6 hours prior to oviposition via brachial vein cannulation for plasma estrogen (E₂), luteinizing hormone (LH), and progesterone (P₄) determination. Hens were then euthanized by cervical dislocation and CaT determined. For W-36 hens, CaT was significantly greater than that found in Brown hens (P=0.042) while for W-98 there were no differences from W-36 or Brown strains (P=0.170 and 0.427), respectively. P₄ and LH concentrations were not significantly different in the three varieties of laying hens. E₂ concentration for Brown hens was significantly greater than that found in W-36 and W-98 hens (P=0.001 and 0.043, respectively), while for W-98 the E₂ concentration was significantly greater than that found in W-36 (P=0.083). Based on the higher CaT by duodenal cells and the lower plasma levels of E₂, these results suggest a higher efficacy of the W-36 hens in calcium regulation during the terminal phase of egg production (more than 100 weeks of age), compared to the Brown and W-98 hens. However, when specific gravity and thickness of shells were compared, the W-36 appeared to have no advantage over W-98 (P=0.460 and 0.684) or Brown (P=0.197 and 0.941) hens, respectively.

Key Words: Laying hens, Calcium transport, Reproductive hormones

1636 Estrogen receptor populations in various calcium regulating tissues in laying hens at three ages. K. K. Franzen^{*1}, D. Clopton¹, N. Caceres², G. Sarath², and M.M. Beck¹, ¹Animal Sciences Dept., University of Nebraska, ²Biochemistry Dept., University of Nebraska.

Older hens in production lay larger but fewer eggs than younger birds and the incidence of soft and broken shells is greater in older hens than younger (Joyner et al., 1987). These changes are attributable at least in part to changing hormone profiles and diminished ability of the hen to process calcium at the duodenum (Al-Batshan et al., 1991; Hansen and Beck, 1997). However, in a recent study, duodenal cells from older birds (≥ 71 wk) were able to take up ⁴⁵Ca as well as hens at 26-29 wk of age despite reduced estrogen (E₂) and progesterone (P₄) concentrations (Franzen and Beck, 2000). In further exploration of this relationship, a study was conducted with three ages of Hy-Line W-36 birds: pre-lay pullets (PL; 19 wk, 0% production) peak-production hens (PP; 29 wk, 93% production), and late stage hens (LS; 71 wk, 80% production). Hens from the PP and LS groups were palpated for presence of an egg in the shell gland, and a blood sample for E₂, P₄ and luteinizing hormone (LH) determinations was drawn from the brachial vein of all birds 4-6h prior to expected oviposition. Hens were then euthanized and tissues (kidney, duodenum, shell gland, hypothalamus) were removed for quantification of estrogen receptor- α (ER α) populations via immunocytochemical and Western blot analyses. Plasma E₂ and P₄ were both lower in LS birds than in either PL or PP birds (P \leq 0.05), but LH did not differ across ages. ER α staining was not different among age groups in shell gland; however, in both kidney and duodenum, PL birds had fewer receptors than LS birds (P \leq 0.05), with PP birds being intermediate. When comparisons were made within age, only LS hens had differences between tissues: ER α staining was greater in duodenum than in kidney or shell gland (P=0.0016, 0.0427) with the least amount of staining in the kidney (P \leq 0.10), the primary site of E₂ action on calcium regulatory processes. PL and PP birds had no differences in ER α occurrence in the various tissues.

Key Words: Estrogen receptors, Laying hen, Aging

1637 Frequency of Preovulatory Luteinizing Surges in Turkey Hens and Egg Production Rate. H.-K. Liu, D.W. Long, and W.L. Bacon, *The Ohio State University, Wooster OH.*

Whether the interval between preovulatory surges of luteinizing hormone (LH) was different between lines of turkey hens with either poor (RBC3 line, peak at 55%) or excellent (Egg line, peak at 85%) rates of egg production was examined. Twelve laying hens of each line were cannulated and bled hourly (1.5 mL) for 10 d at peak of production. The hens were photostimulated with constant light (24 h light: 0 h dark d⁻¹) to avoid diurnal masking of innate circadian rhythms. Cannula patency was lost during serial bleeding in 5 of the RBC3 line hens and 1 of the Egg line hens, so they were removed from the study. The mean interval between preovulatory LH surges for the RBC3 line hens was longer than for the Egg line hens (39.5 h and 26.0 h, respectively; P < 0.001) and had a higher coefficient of variation (21.9% and 7.2%, respectively). Intersequence LH surges were found in some of the RBC3 line hens (2 of 7 hens), but none were found in the Egg line hens (0 of 11 hens). All preovulatory progesterone (P₄) surges (144 total) were coupled with preovulatory LH surges, but not all LH-P₄ surges were coupled with ovipositions; uncoupled LH-P₄ surges are referred to as blind LH-P₄ surges. The incidence of blind LH-P₄ surges was not different between RBC3 and Egg line hens (23% and 9% of all surges, respectively; P = 0.08). The baseline concentration of LH between surges was higher in the Egg line hens than in the RBC3 line hens (2.39 and 1.82 ng mL⁻¹, respectively P < 0.001), but the baseline and surge amplitude concentrations of P₄ were not different (P > 0.25) between lines, nor was the concentration of estradiol-17 β . It was concluded that the longer interval between LH-P₄ surges was the major factor tested that was associated with the difference in egg production rate between the RBC3 and Egg line turkey hens. A higher incidence of blind LH surges may be a second contributing source of lower egg production in the RBC3 line in comparison to the Egg line turkey hens.

Key Words: turkey hen, luteinizing hormone, egg production rate

1638 Changes in morphology of granulosa cells in heat-stressed laying hens. M. A. Alodan^{*1} and M. M. Beck¹, ¹University of Nebraska.

We know from previous experiments that heat stress (HS) reduces egg production in laying hens, in part at least through disruption of steroidogenesis. We also noted in several studies changes in the morphology of the granulosa cells (GC) at the level of lipid droplets (LD). It has been reported that HS increases lipid oxidation in the hen, and that normal lipid endocytosis is controlled by the amount of lipid in the cell. However, oxidized lipid receptors are not controlled, at least in human macrophages located in the endothelium of blood vessel walls, causing the formation of giant macrophage cells and leading to the formation of plaques in arteries. The aim of this study was to determine and describe the effect of HS on the morphology of LD in GC of the laying hen and the subsequent recovery to the pre-HS state. Two groups of hens were used; one group was subjected to 24C, 30%RH (control), the other to 36C, 60%RH for 24h (HS treatment). At the end of 24h, the F1 follicles were collected from both groups and the GC monolayers were isolated and fixed in 10% formalin for 24h. The monolayer was then stained using fat stain Oil Red O to localize LDs in the GC. In control GC, LDs were small and uniform in size and shape and they were randomly and evenly distributed in the cells. In contrast, the GC of the HS birds contained much larger LD of different sizes and shapes, and they were arranged neatly around the cell periphery. The percentage of cell area covered by LD in HS GC was significantly (P=0.000) greater than that of the control group. We hypothesize that, during HS, the reduction in activity of GC (steroid production) results in lipid accumulation in the cells. Alternatively, HS-induced lipid oxidation may lead to this accumulation via unregulated oxidized lipid receptors. Both of these are consistent with the recovery that occurs over time in these cells.

Key Words: Laying Hen, Granulosa cell, Lipid oxidation

1639 Active immunization against inhibin enhances reproductive measures in male broiler breeders. S. T. Pittman^{*}, D. G. Satterlee, and G. G. Cadd, *Louisiana State University, Baton Rouge, LA/USA.*

Inoculation of female Coturnix and broiler breeder hens with an inhibin-based immunogen (MBP-cINA₅₂₁) accelerates puberty and enhances egg production. MBP-cINA₅₂₁ is a fusion protein consisting of the *E. coli* Maltose Binding Protein (MBP) and a fragment of the alpha-subunit of chicken inhibin (cINA₅₂₁). Herein, the effect of this immunogen on male broiler breeder development was evaluated. At 13 wk, male breeders (n = 288; Cobb) were randomly assigned into one of four treatment groups based on a primary inoculation of 0 (control), 1, 3, or 5 mg of MBP-cINA₅₂₁ per bird. Booster vaccinations (one-half the primary dose) were given at 18 wk. At 24, 28, and 39 wk, one-third of the birds in each treatment were weighed (BWT), blood sampled and sacrificed. Testes were weighed (TWT) and plasma testosterone (T) levels were determined by RIA. At 24 wk, birds given the 5-mg dose had greater (P < 0.05) BWT and TWT than controls. BWT and TWT responses in birds of the two lowest dosages were intermediate between, but not different from, those of the control or high dose groups. Plasma T levels were higher (> 2-fold; P < 0.05) in birds given 5 mg than in either the control or 1 mg groups. T levels were also appreciably elevated in the 3-mg group but not different from control T responses. No treatment differences were detected in BWT, TWT and T levels at 28 wk. However, by 39 wk, although BWT remained similar in all treatment groups, TWT was greater in males given the 1-mg dose (43 %, P < 0.10) than in controls. TWTs in the 3- and 5-mg groups were also numerically elevated (30 and 37 %, respectively) over control values. Additionally, age-related decline in TWT between 28 and 39 wk was markedly less in all MBP-cINA₅₂₁-treated birds than in controls. Plasma T at 39 wk in the 1-, 3- and 5-mg groups were, respectively, 115, 74, and 67 % greater than those found in the controls. Fighting reduced bird numbers and likely precluded the finding of statistical differences between plasma T means at 39 wk. Mortality was similar in all treatment groups. Collectively, our data suggest that inoculation of male broiler breeders with MBP-cINA₅₂₁ enhanced early measures of puberty and diminished the expected decline in TWT and T levels associated with aging.

Key Words: Broiler breeder, Inhibin, Testes

1640 Dual labeling immunofluorescent staining demonstrates the presence of a protease-inhibiting protein (ovoinhibitor) in the chicken pituitary. C. M. Oubre*¹, K. E. Clements¹, F. Vandesande², and L.R. Berghman¹, ¹Texas A&M University, ²University of Leuven, Belgium.

Ovoinhibitor is a serine protease-inhibiting protein that specifically inhibits serine proteinases such as trypsin and chymotrypsin. During recent attempts to raise monoclonal antibodies (MABS) against chicken bursa of Fabricius proteins, one MAB was produced that specifically recognized chicken ovoinhibitor. This was the first demonstration of ovoinhibitor in an avian immune organ. Further immunocytochemical research revealed that in the pituitary and the brain of the chicken, some cells undeniably displayed immunoreactivity for ovoinhibitor. The present study was aimed at identifying the hypophysial hormone-producing cells that express ovoinhibitor immunoreactivity. Therefore, pituitary glands from 4-week old birds were fixed in phosphate-buffered paraformaldehyde (4% w/v) and 30- μ m vibratome sections were stained as floating sections in 12-well tissue culture plates. The mouse MAB

against Ovoinhibitor was used in conjunction with polyclonal antibodies against Luteinizing Hormone (LH), Growth Hormone (GH), Proopiomelanocortin (POMC) and Prolactin (PRL) and S-100, respectively. The mouse MAB was visualized with a rhodamine-conjugated secondary antibody, whereas the polyclonal rabbit antisera were detected with a biotinylated secondary antibody combined with FITC-conjugated streptavidin. This procedure stained ovoinhibitor-positive cells in red, while the pituitary hormone-positive cells were stained green; overlapping antigens were clearly visible in yellow. The results of these dual-staining experiments revealed partial co-localization of ovoinhibitor with GH, LH, and POMC, each time in a subset of the respective hormone producing cells. By contrast, no co-localization with PRL and S-100 could be demonstrated. Serine protease inhibitors from another family (the serpins) have recently been identified in rat brain and pituitary. In the latter, they have been suggested to play a role in the regulation of cell-extracellular matrix interactions .

Key Words: chicken, pituitary, ovoinhibitor

ASAS Nonruminant Nutrition: Vitamins, Minerals, and Energy

1641 The effect of genotype, parity and folic acid supplement on the expression of leptin, and its receptors in embryonic and endometrial tissues from pigs at 15 days of gestation. F. Guay¹, A. Giguere*², M.-F. Palin², C.L. Girard², J.J. Matte², and J.P. Laforest¹, ¹Laval University, Department of Animal Science, Qc, Canada, ²Dairy and Swine R & D Centre, Lennoxville, QC, Canada.

We have previously demonstrated mRNA expression of leptin (*Lep*) and its receptors (*Lepr* and the long form *Lepr-L*) in endometrium and embryos at 25 days of gestation in sow. We have also shown that expression levels of *Lep* and *Lepr-L* could be influenced by dietary supplement of folic acid (B9). *Lep* and its receptors may therefore have a direct role in the embryo-maternal dialogue. The objectives of this study were to compare the mRNA expression of leptin (*Lep*) in backfat tissue, and its receptors (*Lepr* and *Lepr-L*) in embryonic and endometrial tissues of sows in relation to the genotype, parity, and B9 supplement. Eleven nulliparous Yorkshire-Landrace (GT), 12 multiparous Landrace (LD) and 10 multiparous Meishan-Landrace (ML) sows were randomly assigned to 2 dietary treatments: 0 ppm or 15 ppm of B9 given from the estrous preceding mating up to slaughter, on d15 of gestation. Embryonic and endometrial tissues were collected to evaluate the mRNA expression of *Lepr* and *Lepr-L* while expression levels of *Lep* were assessed in backfat tissue. Blood samples were taken at mating and at slaughter to determine the concentration of circulating leptin; backfat thickness was also recorded. The embryonic *Lepr-L* transcript was barely detectable. Endometrial *Lepr* and *Lepr-L* and embryonic *Lepr* expression were higher in LD than in GT and ML sows ($P < .01$). No B9 effect was seen on *Lep* and its receptors; breed and parity did not influence *Lep* in backfat. Plasma leptin and backfat thickness were higher in ML than in LD and GT sows ($P < .01$). Circulating *Lep* was correlated with backfat thickness ($r = 0.54$, $P < 0.01$) but not with backfat expression levels of *Lep*. These results suggest a developmental regulation of leptin receptors (*Lepr* and *Lepr-L*) in early pregnancy. The effect of B9 on *Lep* gene expression may occur between d15 and d25. Furthermore, in early gestation, the circulating leptin concentration is related to adiposity.

Key Words: Leptin, Sow, Gestation

1642 The effect of genetic type and parity and folic acid supplement on homocysteine metabolism from sows on day 15 of gestation. F. Guay*¹, A. Giguere², M.-F. Palin², C.L. Girard², J.J. Matte², and J.-P. Laforest¹, ¹Laval University, Department of Animal Science, Qc Canada, ²Dairy and Swine R & D Centre, AAC, Qc Canada.

Supplements of folic acid (B9) have been shown to increase prolificacy in multiparous sows by increasing embryo survival. B9 supplement is also recognized to decrease the concentrations of homocysteine (HCY), which is known to be potentially teratogenic. The objective of this study was to compare the effects of B9 supplement on HCY metabolism in early gestating sows. Eleven nulliparous Yorkshire-Landrace (GT), 12 multiparous Landrace (LD) and 10 multiparous Meishan-Landrace (ML) sows were randomly assigned to 2 dietary treatments: 0 ppm or 15 ppm

of B9. Supplements were given from the estrous preceding mating up to slaughter on d15 of gestation. The uterine flushing was collected to evaluate the total content of HCY in the uterine lumen. Blood samples were taken at mating (d0), d5, d10 and d15 of gestation to determine the concentrations of circulating HCY. B9 supplementation had no significant effect on the concentration of circulating HCY, but it decreased ($P \leq .06$) HCY content of uterine flushing in LD (115 16 nmol vs 84 17 nmol) and GT sows (138 23 nmol vs 98 12 nmol) but not significantly in ML sows (117 30 nmol vs 102 30 nmol). ML (18.3 1.3 μ M) and GT (16.6 1.0 μ M) sows had lower ($P \leq .01$) concentrations of circulating HCY than LD sows (24.5 1.3 μ M). These results suggest that a decrease in the content of HCY in the uterine flushing may play an important role in the control of embryo survival by a supplement of B9.

Key Words: Folic acid, Homocysteine, Sow

1643 Phosphorus removal with and without phytase in finishing pigs. G.A. Apgar*¹, C.M. Peter², T.A. Guthrie¹, K.E. Griswold¹, and D.H. Baker², ¹Southern Illinois University, Carbondale, ²University of Illinois, Urbana.

Two trials were conducted using 171 crossbred pigs (53.3 +/- 1.4 kg) to evaluate the effects of removing the inorganic P from finishing diets with or without phytase. The finisher period was broken into two 28-d phases, with the early phase formulated to contain 0.82% lysine and the late phase 0.65% lysine. Dietary treatments (Trt) were: 1) control (early = 0.49% total P, 0.19% available P (aP); late = 0.43% total P, 0.15% aP); 2) control without inorganic P (early = 0.36% total P, 0.07% aP; late = 0.33% total P, 0.06% aP); and 3) diet 2 + 500 U/kg phytase. Pigs were given ad-libitum access to feed and water. Average daily gain, ADFI and G:F were calculated every 2 wks. Pigs were scanned via ultrasound at 98.9 +/- 1.1 kg for 10th rib backfat (BF) and loin eye area (LEA). One barrow and one gilt per pen were slaughtered (ave wt 108.4 +/- 1.4 kg) and metacarpals III and IV collected for bone ash determination. Data were analyzed using the GLM procedures of SAS (1999). The models included the effects of trial, dietary treatment, replicate and all pertinent interactions. There were no significant trial*treatment interactions. During both the early and late phases, pigs fed diet 3 had greater ($P < 0.05$) ADG than pigs fed diet 2. Pigs fed diet 3 also had greater ($P < 0.05$) daily feed intake during the late phase than pigs fed diet 2. Feed efficiency was not affected by dietary treatments. Loin eye area was greater for pigs fed Trt 1 ($P < 0.05$) than those fed Trt 2 and 3, or pigs fed Trt 3 ($P < 0.05$). Pigs fed Trt 1 tended to have greater ($P = .072$) ash content than pigs fed Trt 2 and 3. Removing P during the finishing phase did not alter BF, but reduced LEA and feed intake compared with animals fed a diet with supplemental P. Pigs fed supplemental phytase had improved ADG compared with non-supplemented pigs, but had lower LEA than control pigs.

Key Words: Pigs, Phytase, Finishing

1644 Effects of dietary chromium yeast supplementation on growth performance and carcass characteristics in growing-finishing pigs. C. Y. Liu*, J. N. Hsu, and L. C. Cheng, *Pig Research Institute Taiwan, ROC.*

Two experiments were conducted to evaluate the effects of chromium yeast on growth performance and carcass characteristics in growing-finishing pigs. In Exp. 1, 60 crossbred pigs (average 39.7 kg BW; 4 pigs/pen, 5 pens/treatment) were fed a corn-soybean meal diet (16% CP and .8% lysine) supplemented with 0, 200, or 400 ppb of Cr from chromium yeast (S.I. Lesaffre). Backfat and loin eye area were measured at termination from 2 pigs/pen with close BW. The addition of Cr increased ADG (788, 847, 857 g/d; $P < .05$) but did not affect ADFI (2.45, 2.56, 2.56 kg/d) or F/G ratio (3.13, 3.02, 2.98). Backfat was significantly reduced by Cr supplementation at 400 ppb level (2.73, 2.52, 2.29 cm; $P < .01$) without changes in loin eye area (45.2, 46.7, 47.3 cm²). In Exp. 2, 18 crossbred pigs (average 87.2 kg BW) were individually fed a basal diet (16% CP and .8% lysine) without or with 800 ppb of Cr for final 3 weeks. All pigs were slaughtered for determination of backfat and loin eye area. Dietary 800 ppb of Cr increased ADG (941 vs 1118 g/d; $P < .05$) and backfat (2.39 vs 2.77 cm; $P < .1$); however, ADFI (2.78 vs 3.27 kg/d), F/G (2.97 vs 2.91) or loin eye area (44.9 vs 47.4 cm²) were not significantly ($P > .1$) changed. The results of this study indicate that dietary Cr as chromium yeast is effective to improve performance and its effects are dependent on dietary level and feeding phase.

Key Words: Pigs, Chromium yeast, Performance

1645 Vitamin E and selenium improve pork stability in finishing pigs fed diets deleted of vitamin-mineral premix. S. C. Choi*¹, B. J. Chae, and In K. Han², ¹*Division of Animal Res. Sci., Kangwon National University,* ²*Dept. of Animal Sci. and Tech., Seoul National University, Suwon, Korea.*

Two feeding trials were conducted to determine the effect of inclusion levels, or deletion of vitamin-mineral (VM) premixes on growth performance and pork stability in finishing pigs. In expt. 1, a total of ninety-six pigs (L×Y×D, 85.09±3.12kg) were employed for a 4-week feeding trial. Treatments were 50% (Control), 100%, 150%, and 200% of NRC (1998) requirements for vitamins and trace minerals. In expt. 2, a total of 108 pigs (L×Y×D, 84.76±.58kg) were employed for a 4-week feeding trial. Treatments were 0% (Control), 200% VM, and 200% vitamin E and Se listed in NRC(1998) requirements. After feeding trials, four pigs/treatment were sacrificed for the analysis of pork quality. ADG and feeding/gain (F/G) were the best at 150% VM addition level (quadratic, $p < .05$) among treatments. Dressing percentage and backfat thickness in pigs were not affected by different addition levels of VM premixes. Pork stability in terms of TBARS was linearly ($p < .05$) improved as dietary VM premix was increased (expt. 1). ADG, F/G and pork stability (TBARS) were also reduced ($p < .05$) when VM premixes were deleted. However, adding vitamin E and Se improved ($p < .05$) ADG and pork stability in pigs fed diets deleted VM premix (expt. 2). It might be concluded that adding vitamin E and Se is necessary in finisher diets deleted VM premix for pork quality.

Key Words: Vitamin-mineral premix, Vitamin E, Se

1646 Effect of calcium to phosphorus ratio on grower-finisher pig performance and mineral excretion. J.J. Callan*¹, S.M. Brady¹, D. Cowan², M. McGrane³, and J.V. O' Doherty, ¹*University College Dublin,* ²*Novo Nordisk, Novo Nordisk S.A., Chesham, Bucks, UK* , ³*Trouw Nutrition, Leixlip, Co. Kildare, Ireland.*

Two experiments were conducted to evaluate the effects of phosphorus (P) level and Calcium (Ca): total P (tP) ratio on the efficacy of microbial phytase when added to diets containing barley, wheat and soya bean meal. In experiment 1, 48 entire male pigs were fed individually food containing (T1) 5.5 g/kg tP and 7.0 g/kg Ca, (T2) 5.5 g/kg tP and 7.0 g/kg Ca and 750 FYT/kg of *Peniophora lycii* (*Pen. lycii*) phytase, (T3) 4.3 g/kg tP and 7.0 g/kg Ca and (T4) 4.3 g/kg tP and 7.0 g/kg Ca and 750 FYT/kg of *Pen. lycii* phytase. In experiment 2, 48 entire male pigs were fed individually food containing (TT1) 4.3 g/kg tP and 7.0 g/kg Ca, (TT2) 4.3 g/kg tP and 7.0 g/kg Ca and 750 FYT/kg of *Pen. lycii* phytase, (TT3) 4.3 g/kg tP and 4.3 g/kg Ca and (TT4) 4.3 g/kg tP, 4.3 g/kg Ca and 750 FYT/kg of *Pen. lycii* phytase. In experiment 1, the pigs offered the low P diets had a lower P ($P < 0.001$) and Ca ($P <$

0.05) intake and a lower faecal P and Ca excretion ($P < 0.05$) than the pigs given the adequate P diets. These pigs also had a lower daily gain ($P < 0.01$), feed intake ($P < 0.05$) and feed conversion ratio (FCR) ($P < 0.05$). The inclusion of phytase to both the adequate and the low P diets increased energy and Ca digestibility ($P < 0.05$). In experiment 2, lowering the Ca: tP ratio from 1.6:1 to 1.0:1 increased the DE content of the diet ($P < 0.05$). The inclusion of phytase increased the digestibility of the N and Ca as well as the DE content ($P < 0.05$). There was a significant ratio by phytase interaction ($P < 0.5$) in P digestibility. The inclusion of phytase increased P digestibility when added to the 1.0:1 ratio diet, however phytase had no effect when added to the 1.6:1 ratio diet. The inclusion of phytase increased ($P < 0.05$) feed intake and weight gain. Lowering the Ca: tP ratio resulted in an improvement in FCR (2.3 v 2.4, s.e.m 0.03; $P < 0.05$). In conclusion the beneficial effects of phytase supplementation are adversely affected by a wide Ca: tP ratio.

Key Words: Pigs, Phytase, Ratio

1647 Determination of true phosphorus digestibility and the gastrointestinal endogenous phosphorus loss associated with soybean meal for growing-finishing pigs. A. Ajakaiye*, M. Z. Fan, T. Archbold, R. R. Hacker, C. W. Forsberg, and J. P. Phillips, *University of Guelph, Guelph, Ontario, Canada.*

A trial was conducted to determine true phosphorus digestibility and the gastrointestinal endogenous phosphorus loss associated with soybean meal fed to growing-finishing barrows. Four Yorkshire barrows, an average initial BW of 40 kg, were fed four diets according to a 4 x 4 Latin square design with four experimental periods. The diets were cornstarch-based containing four levels of phosphorus (0.09, 0.18, 0.27, and 0.36%, on as-fed basis) from solvent-extracted soybean meal. Chromic oxide (0.35%) was included as a digestibility marker. Each experimental period consisted of 8-d with 4-d adaptation and 4-d collection of representative fecal samples. Average feed intake was 2,500 g/d with free access to water. True fecal phosphorus digestibility value was determined by regression analysis technique. The true fecal phosphorus digestibility, corrected for the gastrointestinal endogenous phosphorus loss was determined to be 52.0±10.3% in soybean meal. The gastrointestinal endogenous phosphorus loss in feces was estimated to be 0.52±0.10 g/kg DM diet intake. The endogenous phosphorus loss is an inevitable component of total phosphorus requirement in the growing-finishing pigs. True phosphorus digestibility values in feed ingredients for growing-finishing pigs should be determined.

Key Words: Endogenous phosphorus, True phosphorus digestibility, Soybean meal for pigs

1648 Boron supplementation to pigs increases the production of tumor necrosis factor-alpha and interferon-gamma. T.A. Armstrong* and J.W. Spears, *North Carolina State University, Raleigh.*

Two experiments were conducted to determine the effects of dietary boron (B) on the production of cytokines following an endotoxin challenge. In both experiments pigs were obtained from litters generated from sows fed low B (control) or B-supplemented (5 mg/kg) diets. In experiment (Exp) 1 and 2, 28 and 35 pigs, respectively, (21 d old) remained with their littermates throughout a 49 d nursery phase and were maintained on either a control or B-supplemented diet. In Exp 1, 12 pigs/treatment were moved to individual pens at the completion of the nursery phase and maintained on their respective experimental diet. On d 99 of the study, pigs were injected with 150 µg phytohemagglutinin (PHA) to evaluate a local inflammatory response. Pigs receiving the B-supplemented diet had a decreased ($P < 0.01$) inflammatory response following PHA injection. Peripheral blood monocytes were isolated from 6 pigs/treatment on d 103 and cultured in the presence of lipopolysaccharide (LPS) to determine the effect of B upon tumor necrosis factor-α (TNF-α) production from monocytes. Isolated monocytes from B-supplemented pigs tended to have a higher production of TNF-α. In experiment 2, pigs were group housed with their littermates following the nursery phase for 43 d, after which 10 pigs/treatment were moved to individual pens. In Exp 1 and 2, pigs were randomly assigned within dietary treatment to receive either an i.m. injection of saline or LPS at d 117 and d 109, respectively. The dose of LPS in Exp 1 and 2 was 100 and 25 µg LPS/kg BW, respectively. In Exp 1, serum TNF-α was increased ($P < 0.01$) at 2 h and tended to be increased ($P < 0.11$) at 6

and 24 h post-injection by B; however, only numerical trends existed for a B-induced increase in TNF- α in Exp 2. Serum interferon- γ (IFN- γ) was increased ($P < 0.01$) at 6 h and tended to be increased ($P < 0.08$) at 24 h post-injection in Exp 1. In Exp 2, B also tended to increase IFN- γ . These data indicate that B supplementation increases the production of cytokines, which indicates a role of B in the immune system. However, these data do not explain the reduction in localized inflammation following an antigen challenge in pigs.

Key Words: Boron, Inflammation, Cytokines

1649 The effects of α -lipoic acid (LA) on performance and health of weaned neonatal pigs. K. R. Maddock^{*1}, E. P. Berg¹, C. A. Stahl¹, M. L. Linville¹, and J. A. Carroll², ¹University of Missouri, Columbia, ²ARS-USDA, Columbia, MO.

Two trials were conducted to evaluate the potential benefit of supplemental LA on growth, feed conversion, and health status of neonatal pigs. For both trials, gilts were weaned into individual pens at 21d of age, and treatments were administered orally for 11d. On d11, gilts were nonsurgically fitted with jugular cannulae. On d12, gilts received a dose of lipopolysaccharide (LPS; 150 μ g/kg) intravenously. Blood samples were collected at 15-min intervals for 30 min prior to, and 180 min after, LPS to monitor serum glucose, cortisol, tumor necrosis factor- α (TNF- α), and neutrophil and lymphocyte counts. Trial 1 consisted of 18 gilts (6.74 \pm 0.63 kg) allotted to three treatments: 1) no supplemental LA (CON, n=6); 2) LA1, 35 mg/kg BW daily (n=6); 3) LA2, 75 mg/kg BW daily (n=6). ADG ($P < 0.05$) and ADFI ($P < 0.05$) were greater in CON pigs compared to LA1 and LA2 pigs. There was no effect of LA on serum glucose, cortisol, TNF- α , % neutrophils, and % lymphocytes. LPS increased serum glucose, cortisol, TNF- α , and decreased % neutrophils and % lymphocytes ($P < 0.001$). A linear contrast of serum glucose showed a trend ($P < 0.1$) such that LA1 was lower than CON. Trial 2 consisted of 21 gilts (7.05 \pm 1.12 kg) allotted to three treatments: 1) no supplemental LA (CON, n=7); 2) LA3, 8 mg/kg BW daily (n=7); 3) LA4, 15 mg/kg BW daily (n=7). There were no LA effects on ADG, ADFI, cortisol, insulin, % neutrophils and % lymphocytes or lymphocyte counts. LPS increased serum glucose, cortisol, TNF- α , and decreased neutrophil counts and lymphocyte counts ($P < 0.001$). There was a time by LA effect in serum glucose ($P < 0.004$) where LA3 and LA4 were higher than CON. Time 0 neutrophil counts were higher ($P < 0.003$) in the LA3 and LA4 pigs compared to CON pigs. These results suggest that supplementing LA does have an effect on glucose during an LPS challenge, and an effect on neutrophil populations.

Key Words: α -Lipoic acid, Immune, Neonatal pig

1650 Effects of feeding different chelated copper and zinc sources on growth performance and their excretions in feces for weaning pigs. S. H. Lee^{*1}, S. C. Choi, W. T. Kim, B. J. Chae, and Y. K. Han², ¹Division of Animal Res. Sci., Kangwon National Univ., ²Feed Res. Inst., National Agri. Coop. Fed., Anyang, Korea.

Two feeding trials were conducted to study the effects of dietary Cu and Zn sources on performance and fecal excretions of Zn and Cu for weaning pigs. In Expt. 1, a total of 150 pigs (L \times Y \times D, 12.30 \pm 2.07kg) were randomly assigned to five treatments with three replicates (10 pigs/pen): 170 ppm Cu from CuSO₄, 85 ppm Cu from Cu-amino-chelate[®] (CAC), 170 ppm Cu from CAC, 85 ppm Cu from Cu-Lysine (CL), and 170 ppm Cu from CL. In Expt. 2, a total of 150 pigs (L \times Y \times D, 12.52 \pm 1.8kg) were randomly assigned to five treatments with three replicates (10 pigs/pen): 120 ppm Zn from ZnSO₄, 60 ppm Zn from Zn-amino-chelate[®] (ZAC), 120 ppm Zn from ZAC, 60 ppm Zn from Zn-Methionine (ZM), and 120 ppm Zn from ZM. Each expt. was conducted for 28 days. A metabolic study was also conducted to determine the fecal excretions of Cu and Zn in pigs fed the diets containing the above minerals sources. Fifteen pigs (13.51 \pm 1.6kg) were assigned to five treatments (3 pigs/treatment) in individual metabolic cages to collect feces. There was no difference ($p > .05$) in ADG and ADFI among treatments, but FCR was improved ($p < .05$) in pigs fed the 170 ppm CAC than 85 ppm CL (Expt. 1), and the ADG was higher ($p < .05$) in pigs fed the 120 ppm ZM than the 120 ppm inorganic and 60 ppm ZAC and ZM (Expt. 2). The fecal excretions of Cu and Zn were reduced ($p < .05$) when those minerals were chelated with amino acids. It might be concluded that the efficacy of the chelated Cu and Zn with amino acids or single amino acid are similar in terms

of performance, and fecal excretions of the minerals can be reduced in pigs fed chelated ones.

Key Words: Cu, Zn, Pig

1651 Dietary copper source and level increases pituitary growth hormone mRNA levels in weaning pigs. X. G. Luo^{*1}, X. Kuang¹, Q. H. Li¹, J. F. Li¹, T. D. Crenshaw², B. Liu¹, G. Z. Shao¹, and S. X. Yu¹, ¹Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, P. R. China, ²University of Wisconsin, Madison, U. S. A..

An experiment was conducted with 30 crossbred (Landrace \times Large White) weaning barrows averaging 9.5 kg BW and 35 d to investigate the effects of dietary Cu source and level on growth, plasma growth hormone (GH) levels, tissue Cu contents, and pituitary GH mRNA levels. Pigs were randomly allotted by bodyweight and litter to one of three treatments in a randomized complete block design, and fed basal corn-soybean meal-whey diets supplemented with 15 (n=6) or 250 ppm Cu as Cu sulfate (n=12) or 250 ppm Cu as Cu-glycine (n=12), respectively. There were six pigs for the 15 ppm Cu treatment and 12 pigs for each of the two 250 ppm Cu treatments. Pigs were individually kept in fiber glass metabolism crates in a metabolism room for the duration of the 28-d experiment. Pigs were allowed free choice continuous access to feeds and tap water. Pigs were individually weighed and feed intake was recorded weekly. At the end of the trial, a blood sample was taken from each pig, and then all pigs were slaughtered for tissue sample collections. Pituitary gland samples were frozen in a liquid nitrogen immediately after taken, and pituitary GH mRNA levels were determined by RT-PCR procedure. Neither Cu source nor Cu level affected ($P > 0.10$) growth rate, feed intake, feed conversion ratio, plasma GH levels, or Cu contents in plasma, pancreas, kidney and spleen. However, pigs fed the diet with 250 ppm Cu added as Cu-glycine had higher ($P < 0.007$) pituitary GH mRNA levels than pigs fed diets with 15 or 250 ppm Cu as Cu sulfate. Pigs fed diets with 250 ppm Cu added from either Cu sulfate or Cu-glycine had increased ($P < 0.002$) Cu contents in brain, liver and heart compared to pigs fed the diet with 15 ppm Cu added from Cu sulfate. No differences ($P > 0.60$) were detected between the two Cu sources. These results indicate that Cu could enhance the growth of young pigs by promoting the pituitary GH gene expression; Pituitary GH mRNA levels might be more sensitive than conventional serum or plasma GH levels as a reflection of GH status in the body; And organic Cu-glycine was more effective than inorganic Cu sulfate in increasing pituitary GH mRNA levels in weaning pigs. Supported by the National Natural Science Foundation of China (Project No: 39600107).

Key Words: Copper, Pituitary GH mRNA, Weanling pigs

1652 Effects of long-chain polyunsaturated fatty acids (LCPUFA) on body composition and tissue accretion rates in the neonatal pig. S. A. Mathews^{*1}, R. J. Harrell¹, W. T. Oliver¹, J. A. Brown¹, O. Phillips¹, X. Lin¹, J. Odle¹, and D. A. Diersen-Schade², ¹North Carolina State University, Raleigh, ²Mead Johnson Nutritionals, Evansville, IN.

The effects of LCPUFA supplementation and source on body composition and tissue accretion rates were examined in the neonatal pig. Piglets had *ad libitum* access from d 1 to 16 of age to a skim milk-based formula with different fat sources added to provide 50% of the energy. Fat sources included LCPUFA as follows: single cell oil triglyceride (TG), egg phospholipid (EPL), TG with phospholipid and cholesterol added to match EPL (TG+PL), a control with no added LCPUFA (CTL), and an essential fatty acid deficient diet (EFAD). Formulas with LCPUFA provided 0.6% of fatty acids as arachidonic acid and 0.3% as docosahexaenoic acid. A group of 10 piglets remained on the sow for the duration of the study (Sow). An initial group of 10 piglets were taken at d 1 of age to serve as a reference group. Average daily gain was similar in all groups (320 \pm 20 g/d, $P > 0.1$). Average daily feed intake (1953 \pm 68 g/d) and feed efficiency (1.58 \pm 0.06) was similar across all treatments ($P > 0.1$). Whole body tissue accretion data are presented below. Protein accretion was greater in the TG, TG+PL and EPL fed piglets compared to the EFAD fed and sow-reared piglets ($P < 0.03$). Accretion of fat was greatest in the sow-reared piglets ($P < 0.0001$). TG fed piglets had greater fat accretion than the PL or the EFAD fed piglets ($P < 0.02$). Water accretion was greater in the TG, TG+PL, PL and CTL compared to the sow-reared and EFAD piglets ($P < 0.05$). These data demonstrate

that the source of LCPUFA increased protein and water accretion, but resulted in a decrease in the amount of fat accretion.

	CTL	EFAD	TG	TG+PL	PL	Sow	SEM
Protein, g/d	39.9 ^{a,b}	24.9 ^b	44.9 ^a	39.9 ^a	39.8 ^a	29.6 ^b	1.5
Ash, g/d	6.4 ^{a,b}	5.4 ^b	7.5 ^a	7.3 ^a	6.4 ^{a,b}	6.4 ^{a,b}	0.3
Water, g/d	208 ^a	178 ^b	229 ^a	215 ^a	201 ^a	161 ^b	6
Fat, g/d	28.4 ^{a,c,d}	24.5 ^c	32.6 ^d	30.6 ^{a,c,d}	24.7 ^{a,c}	47.6 ^b	1.4

^{a,b,c} Within a row, treatments lacking a common superscript differ ($P < 0.05$).

Key Words: Long chain PUFA, Pig, Neonate

1653 Utilization of energy and performance of piglets fed low protein diets. L. Le Bellego* and J. Noblet, *INRA, St Gilles, France.*

Eight blocks of five to six castrated male littermates were used to study the effect of reducing dietary CP level on performance and energy utilization in piglets. Four wheat - barley - corn - soybean meal diets (D1, D2, D3 and D4) providing 1.0 g of standardized digestible lysine per MJ NE were prepared. The reduction of CP was achieved by partial replacement of soybean meal by wheat, barley and corn; CP levels were 22.4, 20.4, 18.4, 16.9% and NE contents were 10.28, 10.33, 10.52, and 10.52 MJ/kg for D1, D2, D3 and D4, respectively. Diets were supplemented with industrial AA in order to maintain an optimal AA supply. One or two littermates per block were slaughtered at the beginning of the experiment (about 12 kg BW) to measure initial body composition, and the four remaining littermates were affected to the four diets. Pigs were penned individually with *ad libitum* access to feed and water and were slaughtered at about 27 kg. Gain of nutrients and energy were calculated according to the comparative slaughter technique. Reduction of dietary CP level resulted in higher ADFI ($P=0.05$) with D2, D3 and D4 (1049 g/d on average) than with D1 (959 g/d). However, ADG was not affected by diet composition (666 g/d on average). Adjustment of data for identical ME intakes (2.52 MJ/d/kg BW^{0.60}) revealed that BW gain and its composition were not affected by dietary CP level; mean daily gains of empty BW, water, protein and lipid were 100.0, 75.7, 18.9 and 13.0 g/kg BW^{0.60}, respectively; daily ash gain decreased ($P<0.05$) from D1 (3.0 g) to D4 (2.7 g). The partition of daily ME intake between energy gain and heat production was comparable for all diets (0.94 and 1.58 MJ/kg BW^{0.60}, respectively). The AA composition of gain (% of N x 6.25) was not affected by dietary CP level, except for histidine that was reduced ($P<0.05$) from D1 (2.95%) to D4 (2.40%). These results demonstrate that, at optimal AA supplies, dietary CP level in piglet feeds can be reduced to a large extent with no impact on performance, composition of gain and energy utilization in piglets; N excretion is then markedly reduced.

Key Words: Piglet, Dietary Protein, Energy Utilization

1654 Effects of feed processing methods on growth performance and ileal digestibility in weaning pigs. S. H. Ohh*¹, J. W. Joo, S. H. Lee, S. C. Choi, Y. H. Shim, K. N. Han, B. J. Chae, and In K. Han², ¹*Division of Animal Res. Sci., Kangwon National Univ., Chuncheon,* ²*Dept. of Animal Sci. and Tech., Seoul National Univ., Suwon, Korea.*

Two feeding trials were conducted to compare the processing effects of feeds in young pigs. In expt. 1, a total of 108 pigs (L×Y×D; 24-d old, 7.60±.5kg BW) were randomly allotted to three treatments (three replicates, 12 pigs/pen): Meal (M), simple pellet (SP), and expanded pellet (EP). In expt. 2, a total of 96 pigs (L×Y×D; 14-d old, 5.21±.77kg BW) were randomly allotted to three treatments (four replicates, 8 pigs/pen): M, EP, and expanded crumble (EPC). Each expt. was conducted for 14 days. Diets were pelleted with 2.8mm die in diameter at 40°C. For expanding, diets were expanded at 70°C, and then pelleted with 2.8mm die in diameter at 60°C, and crumbled, according to the designs. The ileal digestibilities of expanded whey powder (WP), spray-dried plasma protein (SDPP), and fish meal (FM) were determined with cannulated pigs (7.44±1.6kg) with different expanding temperatures: 100, 120, and 140°C, respectively. The ADG, ADFI and F/G of pigs fed a SP diet were better ($p<.05$) than those fed M or EP diets (expt. 1). In expt. 2, there was no difference ($p>.05$) in ADG, but feed intake was reduced, resulting in improved ($p<.05$) F/C in pigs fed EP and EPC as compared with those fed a M diet. The ileal digestibilities of histidine in WP, isoleucine

in SDPP, and valine in FM were reduced ($p<.05$) when the temperature was 140°C, but ileal digestibilities of most amino acids were not reduced when these ingredients were expanded at up to 120°C. It could be concluded that simple pelleting of diets containing highly palatable and digestible ingredients would be better than expanding and expander processing of the diets could reduce palatability and ileal digestibility in weaning pigs.

Key Words: Pelleting and expanding, Digestibility, Pig

1655 The effect of pelleting temperature on anti-*E. coli* F4 immunoglobulin activity in spray-dried egg and porcine plasma. M. D. Drew*, A. E. Estrada, and A. G. Van Kessel, *University of Saskatchewan, Saskatoon SK Canada.*

The effects of pelleting on the activity of chicken egg immunoglobulin (Ig) or porcine plasma Ig in feed was tested. Hyperimmune chicken egg Ig specific for *E. coli* F4 was produced by immunizing laying hens with an *E. coli* F4 bacterin. The immune eggs were spray-dried prior to use. Spray-dried porcine plasma (AP920, American Protein Corporation) and the spray-dried egg Ig were added to a barley and wheat based pig starter ration at a level of 5% of the diet. The diets were then pelleted at 80, 90 or 105°C (pellet temperature measured at the die outlet) through a die containing holes 5 mm in diameter. Anti-F4 titers of the unpelleted and pelleted feeds were measured using an enzyme-linked immunosorbent assay (ELISA). The feed samples were diluted 1:100 with phosphate buffered saline and shaken overnight. The solids were then allowed to settle and the supernatants were applied to ELISA plates coated with purified F4 antigen in a series of doubling dilutions. Endpoint titers were defined as the last dilution that produced an absorbance plus 3 standard deviations above background. The anti-F4 Ig titer of plasma was 1:1,600 in the pre-pelleted feed. This was reduced to 1:800, 1:400 and 1:200 by pelleting at 80, 90 or 105°C respectively. The anti-F4 Ig titer of the egg Ig was 1:6,400 in the unpelleted feed. Pelleting at any of the three temperatures used in this experiment completely destroyed anti-F4 Ig activity measured by ELISA. The results demonstrate that egg Igs are more sensitive to heat denaturation during pelleting than plasma Igs. Incorporation of egg Ig products into animal diets should be done after pelleting if diet temperatures of greater than 80°C are used. Porcine plasma Igs are more resistant to heat denaturation than egg Igs but temperatures of 80°C or higher reduce specific porcine Ig activity in pelleted feeds.

Key Words: Pelleting, Egg immunoglobulin, Plasma

1656 Solutein enhances piglet growth post weaning. H.M. Miller*¹ and P. Toplis², ¹*University of Leeds, Leeds, LS2 9JT, UK,* ²*Primary Diets Ltd, Ripon, HG4 5HT, UK.*

Piglets fed diets containing porcine plasma (PP) in wk1 post-weaning have better feed intakes and growth rates than piglets fed skim milk based starter diets. We aimed to determine whether similar improved piglet performance occurred when piglets received Solutein (soluble PP) in their water supply instead of in feed. We also investigated whether Solutein in water further improved performance of piglets receiving a PP based diet. One hundred and twenty eight 25.1d old (sd = 4.22) piglets (62.5% Large White, 25% Landrace, 12.5% Duroc) weighing 7.8kg (sd = 1.91) were weaned into fully slatted flat deck pens. Piglets were not creep fed pre-weaning. Each pen (1.37m x 1.43m) contained 8 pigs allocated on the basis of litter, liveweight and sex. Four treatments were fed until d14 post-weaning: A Control, no plasma, B plasma in water, C plasma in feed, D plasma in water and feed. Solutein was included in the water for 5d at 2.4%, then for 5d at 1.2% and for a further 4d at .7%. Four pens were randomly allocated to each treatment. Diets contained ZnO (Zn 2500 ppm) and were formulated to contain 16.3 MJ DE/kg, 1.65% total lysine. From d14 onwards all piglets received the same diet (15.0 MJ DE/kg, 1.5% total lysine) and no water supplementation. Pigs were individually weighed at 0, 7, 14 and 20d post-weaning. Food and water were provided *ad libitum* throughout the 20d trial. Data were analysed using the GLM procedure of Minitab 12.2. Growth rate, 184 v 117 14 g/d, and FCR, 0.98 v 1.50 0.07, were better for all PP supplemented pigs than control pigs in wk1, ($P<.05$). No additional benefit accrued from PP in both feed and water. End BWs of PP fed pigs were numerically greater than those of control pigs but this failed to reach significance (14.5 v 13.9 0.3 kg). Feed intake over the 20d trial was greater for C piglets than for any other treatment ($P<.05$). All 3 PP treatments were equally effective in stimulating piglet performance

during wk 1 of the trial. Therefore PP in water is as effective as in the diet. PP in both diet and water gave reduced feed intake in wk3.

Key Words: Piglet, Plasma, Growth

1657 Effect of weaning weight and diet on the post-weaning performance of pigs. P.G. Lawlor^{*1}, P.B. Lynch¹, J.V. O'Doherty², and P.J. Caffrey², ¹Teagasc, Moorepark Research Centre, Cork, Ireland, ²University College Dublin, Ireland.

The objective of this experiment was to assess the effect of weaning weight and post-weaning diet on the performance of weaned pigs. Pigs were weaned from 32 litters at 22 days of age. Four pigs (2 light and 2 heavy) were taken from each litter (n=128), blocked on sex, litter origin and weaning weight and individually assigned at random to 2 dietary treatments; (1) high density diet (230 g/kg wheat, 200 g/kg maize, 175 g/kg full-fat soya, 120 g/kg dried whey, 110 g/kg dried skim milk, 95 g/kg herring meal; 17.4 g/kg lysine and 16.1 MJ DE/kg) and (2) medium density diet (434 g/kg wheat, 100 g/kg maize, 210 g/kg full-fat soya, 75 g/kg dried whey, 50 g/kg dried skim milk, 100 g/kg herring meal; 15.7 g/kg lysine and 15.1 MJ DE/kg). The duration of the experiment was 26 days. There was no interaction between weaning weight and post-weaning diet. Weaning weight was 7.1 and 5.8 kg (s.e. 0.08; P<0.01) and pig weight at day 26 post-weaning was 17.5 and 15.4 kg (s.e. 0.23; P<0.01) for heavy and light weight categories, respectively. The differential in weaning weight was associated with a difference in birth weight, which was 1549 vs. 1379 g (s.e. 28; P<0.01) for heavy and light weight categories respectively. In the period from day 0 to 26 post-weaning, feed intake was 440 and 396 g/day (s.e. 8.0; P<0.01) and daily gain was 389 and 355 g/day (s.e. 8.0; P<0.01) for heavy and light weight categories, respectively. Weaning weight was found to be a good determinant of weight at day 26 when terms for litter origin were included (R²=0.67; P<0.001 for the high density diet and R²=0.77; P<0.001 for the low density diet). Intake from day 0 to 26 post-weaning was not affected by diet (P>0.05). However, daily gain was 384 vs. 360 g/day (s.e. 8.0; P<0.05) and FCE was 1.10 vs. 1.16 g/g (s.e. 0.014; P<0.01) for high density and low density diets respectively. Pig weight at day 26 was 16.8 vs. 16.0 kg (s.e. 0.22; P<0.05) for high density and low density diets respectively. It is concluded that a natural advantage in weaning weight was still evident at day 26 post-weaning. The high density diets improved post-weaning pig performance.

Key Words: Weaning weight, Post-weaning, Pigs

1658 Effect of pre-weaning management and post-weaning nutrition on the performance of weaned pigs. P.G. Lawlor¹, P.B. Lynch^{*1}, J.V. O'Doherty², and P.J. Caffrey², ¹Teagasc, Moorepark Research Centre, Cork, Ireland, ²University College Dublin, Ireland.

The objective of this experiment was to assess the effect of pre-weaning management designed to increase weaning weight and post-weaning (PW) nutrition on the performance of weaned pigs. Thirty litters with more than 10 live born pigs were selected. At 11 days of age, pigs of average weight for the litter were removed from 15 litters so that 8 pigs remained per sow. These litters were given access to creep feed (16.5 MJ DE/kg and 18.7 g/kg lysine) until weaned. The remaining litters were left intact and were not given creep feed. Pigs were weaned at 27 days of age and two mixed sex pairs of pigs were formed from each litter (n=54 pairs). Pairs were blocked on litter origin and weight and assigned to one of the following treatments; (1) 10 kg starter diet (17.4 g/kg lysine and 16.1 MJ DE/kg; 230 g/kg wheat, 200 g/kg maize, 175 g/kg full-fat soya, 120 g/kg dried whey, 110 g/kg dried skim milk, 95 g/kg herring meal) followed by link diet (15.0 g/kg lysine and 15.3 MJ DE/kg; 481 g/kg wheat, 81.5 g/kg maize, 220 g/kg full fat soya, 100 g/kg herring meal, 75 g/kg dried whey) to 27 days PW (high dietary regimen; HDR) or (2) 4 kg starter diet, 10 kg link diet and weaner diet (13.6 g/kg lysine and 14.0 MJ DE/kg; 542 g/kg wheat, 200 g/kg barley, 150 g/kg soya, 75 g/kg herring meal) to 27 days PW (low dietary regimen; LDR). Thereafter pigs were fed common diets to 156 days of age. Reducing litter size and creep feeding increased weaning weight from 7.9 to 8.5 kg (s.e. 0.14; P<0.05). This weight advantage was lost by day 14 PW (P>0.05). Daily gain from day 0 to 27 PW was 472 and 427 g/day (s.e. 12.8; P<0.05) and FCE from day 0 to 27 PW was 1.26 and 1.36 g/g (s.e. 0.026; P<0.01) for HDR and LDR, respectively. Feed intake and daily gain, were similar for both treatments in the period from weaning to day 129 PW (P > 0.05) and from day 27 to 129 PW (P>0.05) respectively.

In the period from day 27 to 50 PW, FCE was improved for LDR (1.66 vs. 1.72, s.e. 0.020; P<0.05). It is concluded that the advantage in weaning weight caused by better pre-weaning management was lost in the early post-weaning period. Feeding a HDR improved performance in the early post-weaning but did not benefit lifetime performance.

Key Words: Creep feed, Post-weaning, Pigs

1659 The effect of choice feeding complete diets on the performance of weaned pigs. P.G. Lawlor^{*1}, P.B. Lynch¹, J.V. O'Doherty², and P.J. Caffrey², ¹Teagasc, Moorepark Research Centre, Cork, Ireland, ²University College Dublin, Ireland.

Three experiments were undertaken to compare choice feeding and phase feeding for weaned pigs (19 to 24 days old). In Experiment 1, 24 mixed sex groups of 16 pigs were blocked on weaning weight and assigned to the following treatments; (A) starter diet (18.3 g/kg lysine and 16.6 MJ DE/kg) for 11 days followed by link diet (15.0 g/kg lysine and 15.3 MJ DE/kg) to 27 days, (B) starter diet and link diet offered free choice to 27 days and (C) starter diet and weaner diet (13.0 g/kg lysine and 14.3 MJ DE/kg) offered free choice to 27 days. In Experiment 2, 66 pigs, blocked as individuals on sex and weaning weight were assigned to treatments as in Experiment 1. In Experiment 3, 24 single sex groups of 16 pigs were blocked on sex and weaning weight and randomly assigned to treatments as in experiment 1 but with treatment C being; starter diet and link diet offered free choice to 26 days with feeder position rotated twice weekly. In Experiments 1 and 3, a weaner diet (14.1 g/kg lysine and 14.4 MJ DE/kg) was fed to all pigs following the experimental period. In Experiment 1, daily gain was 406, 410 and 397 g/day (s.e. 6.7; P>0.05), FCE was 1.25, 1.21 and 1.28 g/g (s.e. 0.01; P<0.01) and the proportion of intake as starter diet was 0.20, 0.50 and 0.47 (s.e. 0.023; P<0.01) during the period from day 0 to 27 for treatments A, B and C, respectively. In the period between day 27 and 57 there was no effect of treatment on pig performance (P>0.05). Within pen variation in pig weight was similar for all treatments at day 14, 27 and 56 (P>0.05). In Experiment 2, daily gain was 403, 436 and 394 g/day (s.e. 13.0; P=0.07), FCE was 1.20, 1.16 and 1.24 g/g (s.e. 0.02; P<0.05) and the proportion of intake as starter diet was 0.19, 0.57 and 0.53 (s.e. 0.024; P<0.01) during the period from day 0 to 26 for treatments A, B and C, respectively. In Experiment 3, daily gain was 465, 486 and 488 g/day (s.e. 9.4; P>0.05), FCE was 1.14, 1.10 and 1.07 g/g (s.e. 0.015; P<0.01) and the proportion of intake as starter diet was 0.21, 0.48 and 0.55 (s.e. 0.022; P<0.001) during the period from day 0 to 26 for treatments A, B and C, respectively. Pig weight at day 49 was 36.4, 37.1 and 37.3 kg (s.e. 0.27; P=0.09). In conclusion, choice feeding improved post-weaning pig performance.

Key Words: Choice feeding, Post-weaning, Pigs

1660 Effects of microencapsulation of natural antimicrobials on the secretory, microbiological and digestive processes in the small intestine of piglets. Z. Mroz^{*1} and W. Krasucki², ¹Institute for Animal Science and Health, ID-TNO Animal Nutrition, Lelystad, The Netherlands, ²Agricultural University of Lublin, Poland.

Ten weaning piglets of 9.5 kg initial BW were fitted with newly developed re-entrant catheters in the exocrine pancreatic duct and with ileal cannulas (SICV) to compare the effects of in-feed natural antimicrobials (bioactive proteins/peptides from milk) without and with a novel, beeswax-based microencapsulation on the pancreatic and mucin secretions, ileal morphology, microflora, and digestion of amino acids. The piglets were sib paired to form 2 blocks (no/yes microencapsulation), and each block was randomly allotted to 5 diets according to a 5 x 5 Latin square design. The diets were as follows: 1) a corn-SBM-based diet (BD)+0.1% placebo; 2) BD+0.1% bovine IgG; 3) BD+0.1% bovine lactoferrin and lactoperoxidase blend (LLB); 4) BD + 0.1% bovine lactoglobulins (LG); 5) BD+0.1% probiotic blend (PB). In each period of 7 d (5-d adaptation and 2-d sampling) piglets were given ad libitum access to feed and water. Exocrine pancreatic secretion (postprandial volume, protein, bicarbonate) were not affected by the diets or microencapsulation, whereas trypsin and chymotrypsin activities were greater (P<0.05) for all the microencapsulated additives. Feeding IgG, LLB, LG and PB in the microcapsules decreased (P<0.05) mucin production in the ileal digesta, with a tendency to improve morphological and histometrical characteristics in the terminal ileum. There was a positive effect (P< 0.05) of microencapsulation on the apparent ileal digestibility

of lysine (+1.5%), methionine (+1.9%), tyrosine (+2.1%) and arginine (+2.5%), irrespective of the additive. Also, due to this microencapsulation, we observed a greater ($P < 0.05$) population of Lactobacilli, whereas hemolytic E.coli counts were reduced ($P < 0.05$). These data imply that in-feed bioactive proteins/peptides addressed as antimicrobials instead of antibiotics should be preferably microencapsulated against their gastric hydrolysis and for enhancing their efficacy along the small intestine of piglets.

Key Words: Piglets, Microencapsulation, Antimicrobials

1661 Effects of dietary conjugated linoleic acid (CLA) on carcass characteristics and serum leptin and lipid profile of rabbits. C. Corino¹, V. Bontempo*², S. Magni¹, and G. Pastorelli¹, ¹University of Milan/Italy, ²University of Molise, Campobasso/Italy.

A study was conducted to determine the effect of conjugated linoleic acid (CLA) synthesized from sunflower oil on growth, carcass characteristics, serum leptin and lipid blood profile of rabbits. One hundred and eight NZW rabbits, half male and half female, averaging 1.80 kg LW, allotted within weight and sex to a randomised complete experimental design, were fed ad libitum conventional pelleted diets supplemented with different fat: 0.5 % sunflower oil (C), 0.25 % sunflower oil and 0.25 % CLA (T1), 0.5 % CLA (T2). CLA oil contained 65 % CLA isomers (Conlinco, Inc., Detroit Lakes, Minnesota 56502 USA). Thirty-six rabbits, 12 of each group, half males and half females, were slaughtered at three different slaughtering weight (age): 2.5 kg (76 d), 2.8 kg (90 d), and 3.1 kg (104 d). No effect of CLA supplementation was observed on ADG, FI, FE, dressing percentage, pH and meat colour. Perirenal fat weight decreased at the medium slaughtering weight ($P = 0.089$) and it increased at the higher slaughtering weight ($P = 0.01$). No effect was observed on interscapular fat. CLA supplementation reduced triglycerides and total cholesterol ($P < 0.05$), and increased serum leptin concentration (2.02, 2.67 and 2.35 ng/ml, respectively, SEM = 0.194, $P = 0.06$). A gender effect was observed on triglycerides with higher values in males than females ($P < 0.01$). A similar effect was also found on leptin, but higher values were measured on females (2.57 vs 2.13 ng/ml, $P = 0.06$).

PSA Nutrition: Feed Regimens, Digestion, and Gut Morphology

1663 Effects of protein levels on ostrich performance and carcass traits. I. Cormier*, M.R. Lefrançois, and R. Bergeron, Université Laval, Québec, Québec, Canada.

This study was conducted to assess the impact of a linear increase in dietary protein levels on performance, carcass quality and health of ostriches. Sixty-four unsexed crossed ostriches were raised in a greenhouse and fed ad libitum complete pelleted diets from 2 to 10 mo of age. Sixteen ostriches were randomly allotted four per pen to either one of four diets containing 18 to 23% CP for the starter (2 to 4 mo), 14 to 18% for grower (4 to 7 mo), and 12 to 15% for the finisher (7 to 10 mo). Except for protein levels, these diets supplied similar amounts of energy, fiber, lysine and methionine per kg of feed within each growing period. Body weight (BW), average daily gain (ADG), feed intake, feed efficiency (FE) were measured throughout the experiment. The ostriches' performance was recorded on a monthly basis. Carcass weight (CW) and yield (CY), viscera, heart and liver weights, meat cuts yields, and meat pH and color were also measured at the end of the trial. Carcasses were cut up into 12 meat parts according to the Canadian Ostrich Association chart and weighed. Meat pH was measured in the fan and inside the leg muscles 6 h post mortem. The Minolta color index (L, a*, b*) was used to assess meat color for these two carcass parts. Data were analyzed according to a complete block randomized design using protein level and body weight as the main factors. Mean live BW and CW were 95.15 ± 0.40 kg and 55.83 ± 1.35 kg, respectively. Cumulative ADG and FE were 310 ± 10 g and 0.160 ± 0.003 , respectively. Mean CY was $57.20 \pm 0.74\%$. Average meat pH was 6.27 ± 0.05 for the inside leg and 6.43 ± 0.06 for the fan. Total meat cuts yield was $40.56 \pm 0.53\%$ of the carcass. Besides the worst oyster cut yield ($P < 0.01$) for the third highest protein level, there was no significant differences ($P > 0.05$) between dietary treatments for the measured variables. There were no leg problems and mortality could not be associated with specific dietary treatments. Our results suggest

Our data suggest that conjugated linoleic acid reduce fatness and total serum cholesterol in rabbits. Our data are also consistent with the hypothesis that CLA has the potential to inhibit atherosclerosis.

Key Words: Dietary conjugated linoleic acid, Rabbit, Serum lipid profile

1662 Physiological adaptation to prolonged food restriction: a model study in growing rats. Ewa Furstenberg*¹, ¹Warsaw Agricultural University, Warsaw, Poland.

Organisms subjected to chronic food restriction attempt to mitigate the effects of deficiency by a series of physiological and behavioral responses, which are considered as adaptation to the low energy intake. Adaptation to energy restriction is expected to occur at different levels i.e. growth, rate, body size and composition, as well as energy metabolism. Whether the animals are able to economize on energy by reducing basal metabolism and whether it is an adaptive process per se resulting in decrease in metabolic rate beyond that predicted for the change in body size and/or composition or it is only secondary to changes in body weight and its components is, however, still controversial. The present study was carried out in 48 young growing female and male rats (RF group), which at different body weights (60, 75, 90, 105g) were subjected to food restriction (FR) by feeding constant stipulated rations (14.2, 15.9, 17.7, 19.4 g of standard laboratory diet, ME=1474kJ/100g, respectively) from ad libitum until maintenance level (i.e. constant body weight). Control group (C, n=24) was fed ad libitum throughout the experiment. During the experiment all rats were subjected to at least 2 measurements of resting metabolic rate (RMR). At the end, anatomical and chemical composition of animals was determined. Main results showed that the animals adapted to progressing energy deficit primarily by reducing final body weight and decreasing body fat and that female rats were more sensitive to food restriction than male rats. With respect to energy metabolism, when RF rats were compared with ad lib controls, RMR (in absolute values or relative to body weight and metabolic body weight) was significantly depressed in male rats, however, in females RMR was increased. Higher RMR in RF females than in female controls could be attributable in part to higher protein body mass. These results highlight some of the important differences between male and female rats in their mode of adaptation to restricted feeding.

Key Words: energy metabolism, food restriction, sex

that growing ostriches can perform equally well across a wide range of dietary protein levels without negative impacts on performance, carcass quality and health.

Key Words: Ostrich, Protein, Carcass

1664 Feeding program for broiler breeder hens based on the prediction equations of metabolizable energy requirements. N.K. Sakomura*, E.R. Freitas, C.B.V. Rabello, A.L. Santos, and O.M. Junqueira, ^{UNESP} Faculdade de Ciências Agrárias e Veterinárias de Jaboticabal - Sao Paulo - Brasil.

The purpose of this study was to evaluate feeding programs based on prediction equations of metabolizable energy requirements for broiler breeder after 55 weeks old. Seven hundred forty broiler breeder females Hubbard Hy-Yield and eighty males Peterson 55 wks of age, were distributed in a randomized design with 4 treatments and 5 replications of 37 birds. The feeding programs were: 1- Feeding according to the lineage recommendation, 2- Energy reduction 2 kcal/bird/day for each week, 3- Feeding according to UNESP (2000) equation: $ME = W^{0.75}(192.76 - 6.32T + 0.12T^2) + 7.62G + 2.40EM$, 4- Feeding according to NRC (1994) equation: $ME = W^{0.75}(173 - 1.95T) + 5.50G + 2.07EM$, where ME=energy requirement (kcal/bird/day), W=body weight (kg), T=temperature (C), G=weight gain (g) and EM=egg mass (g). The energy reduction program provided 417 kcal/bird/day, 181g of body weight gain (BWG) and 63.5 % of egg production from 55 to 66 wks of age. The feeding based on lineage recommendation provided 428 kcal/bird/day, 230 g BWG and 64.0 %. The equations UNESP and NRC promoted more energy intake (447 and 484 kcal/bird/day) consequently higher BWG (286 and 645g) and similar egg production 63,6% and 61,3%, respectively. The feeding programs did not affect the

reproductive performance. According to the results, the energy reduction program promoted a good performance being possible the reduction of 2 kcal/bird /day for each week in the broiler breeder feeding after 55 wks of age. The equations UNESP and NRC promoted higher energy intakes than the lineage recommendation probably because of the body weight of birds that were above than the recommended one for lineage, providing the highest energy requirements of maintenance. The UNESP (2000) equation promoted better adjustment than NRC (1994) in the energy feeding for broiler breeder hens.

Key Words: Broiler breeder, Energy prediction equation, Feeding program

1665 The effect of different energy and protein levels on the performance of W-36 Hy-Line laying hens . M. Shahnazari¹, M. Shivazad¹, A. Kamyab¹, and A. Nikkha¹, ¹University of Tehran, Animal Sci. Dept.

A factorial experiment was conducted to investigate the response of laying hens to various levels of dietary energy and protein. Varying levels of dietary energy (2700, 2800, and 2900 Kcal ME/Kg) each fed at four protein levels (14, 15, 16, and 17%) to 1152 laying hens at 27-32 and 32-40 week old. Birds were randomized into 8 cages, with each of the 12 experimental treatments consisting of 4 replicates. Egg production was not significantly affected by dietary energy, protein contents, or ME by protein interaction ($P > 0.05$). Even though, it tended to increase with increase in energy level. Dietary protein affected egg weight ($P < 0.01$), although there was no significant difference between protein levels. The egg weights with proteins ranging from 14, 15 and 17% was increased from 57.1 to 58.3 and 58.5 g, respectively. There was reduced FI as energy level of the diet was increased ($P < 0.05$). Daily FI was 2.5 g lower when dietary energy was raised ($P < 0.05$). Feed efficiency and feed per dozen eggs responded significantly to increasing dietary ME ($P < 0.05$). Financial returns were less for hens fed on 2900 Kcal ME/Kg and tended to decrease with increase in protein level. There was also energy effect ($P < 0.01$) on eggshell quality. Alterations in dietary ME concentration had no influence on body weight change, however, it was affected ($P < 0.01$) by protein levels. Dietary treatments did not exert any significant effects on the albumen index, cracked and soft-shell eggs and mortality ($P > 0.05$). Maximum hen-day egg production, FE, and lowest feed cost per Kg egg weight were obtained on the ration containing 2800 Kcal ME/Kg and 15% protein.

Key Words: Energy, Protein, Laying hens

1666 Effect of formulation density and feed moisture type additives on broiler performance. J.S. Moritz*, K.J. Wilson, K.R. Cramer, R.S. Beyer, L.J. McKinney, and W.B. Cavalcanti, Kansas State University, Manhattan, KS.

Past research has illustrated that moisture added to corn soybean-based diets at the mixer can improve pellet manufacturing parameters as well as improve adjusted broiler feed efficiencies. Feed efficiencies were adjusted due to moisture additions creating a dilution of nutrients in the diets. Diets with added moisture illustrated higher pellet durabilities and subsequently greater potentials for broilers to utilize feed energy for growth compared to diets without added moisture. The objective of the current study was to determine the effects of moisture additives, diets of different nutrient densities and their combination on broiler performance. Treatments consisted of diets containing different moisture type additives (water/surfactant solution vs. water) and diets of different nutrient densities (NRC density vs. adjusted -high density). Negative control diets, which consisted of the two diets of different nutrient densities without moisture additives were also fed. All diets were fed in a pelleted form. Each of the six diets were fed to ten replicate pens of 45 male Cobb-Vantress broilers during the (3-6) week grower period. Broilers fed diets of adjusted -high density that included moisture additives of either type had significantly higher live weight gains and feed efficiencies compared to broilers fed NRC diets with moisture additives. Adjusted -high density diets that included moisture produced broilers with higher live weight gains ($P = 0.0013$) compared to broilers fed either NRC or adjusted -high density control diets. Mortality percentages were not significantly effected due to diet type. These findings conclude that adding moisture to diets of adjusted -high density may

improve broiler performance above broilers fed diets formulated to NRC specifications with or without added moisture.

Key Words: Broiler Performance, Diet Density, Moisture

1667 Whole wheat feeding and influence of initial body weight on broiler performance. A. Golian*, L.D. Campbell, and W. Guenter, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.

Two experiments were conducted to evaluate whole wheat feeding in broiler chicken production. Initial body weight (Exp1) and fortification of dietary additives (Exp 2) were assessed as treatment variables and the same whole wheat feeding regimen (substitution of whole wheat in the control diet at a rate of 5, 15 and 30% for the periods 10-20, 20-30 and 30-40 days-of-age, respectively) was used in both experiments. The first experiment was a 2*3 factorial design in which 5 replicate groups of 65 birds were fed a control diet or a whole wheat substituted diet and each diet included groups of chicks of low weight (40-44 g / bird), high weight (46-50 g / bird) or random weight. The second experiment was a completely randomized design in which 5 replicate groups of 65 birds were fed a control diet, a whole wheat substituted diet or a fortified whole wheat substituted diet. Whole wheat feeding affected chick body weight gain adversely in Exp 1 (1660 vs. 1945 g / bird) but not in Exp 2 (2405 vs. 2453 g / bird). Breast fillet, gizzard and abdominal fat pad weights as a percentage of body weight were adversely influenced by whole wheat feeding in both experiments. In Exp 1 feed intake and body weight were related to initial chick weight but initial chick weight did not affect chick uniformity (within 10% of the mean body weight) at 20 or 40 days-of-age. There was no interaction between diet type and chick weight groups. Overall feed intake was greater for birds in Exp 2 as compared to Exp 1 (101 vs. 88 g / bird) indicating that the beneficial effects of whole wheat feeding may be influenced by voluntary feed intake.

Key Words: Whole wheat, Initial body weight, broiler chicken

1668 The performance of broiler chickens during and following of different feed restriction methods at an early age. M. Houshmand¹, A. Kamyab², K. Yousefi³, and A. Taghipour Farshi*⁴, ¹University of Yasouj, ²University of Tehran, ³Mobarak Andish Co., ⁴Tehran Shaltouk Research Center.

Abstract. A total of 720 Ross chicks were grown in each of 24 separate floor pens until six weeks of age. In a completely randomized design experiment, the effects of energy and protein dilution, utilizing rice hull at 0, 10, 15, 20, 25, and 30%, during 6 to 12 days of age on broiler performance were examined. Metabolizable energy and crude protein content of the experimental diets were as follows: 3089, 2780, 2626, 2472, 2317, 2163 Kcal/Kg; and 21.45, 19.29, 18.23, 17.16, 15.02, and 16.1 percent, respectively. From 13 to 21 day of age a conventional starter and thereafter a finisher diet was used. During the period of study the chicks had free access to mash feed and water. The chicks were pens weighed periodically and feed intake were measured at the end of each phase feeding period on a pen basis as well. Between day 6 to 12, diet dilution increased feed consumption, reduced body weight gain, energy and protein intake ($P < 0.05$). Due to compensatory growth no significant differences ($P > 0.05$) among treatments in body weight were seen. Feed intake following feed restriction period was less for the birds received diluted diet as compared to control ($P > 0.05$). Meanwhile, FE was somewhat improved among the birds that were fed with diluted diets. Nevertheless, this difference was not statistically significant ($P > 0.05$). Diet dilution, had no significant effect ($P > 0.05$) on carcass composition, liver, and abdominal fat percentage at the slaughter age. In this experiment 20 and 25% dilution diets resulted in a slight increase in body weight gain and improved production efficiency.

Key Words: Diet Dilution, Broiler, Compensatory Growth

1669 The effects of early skip-a-day feeding regimen on the performance of Ross male broiler chicken. K. Yousefi¹, A. Kamyab², M. Houshmand³, and A. Taghipour Farshi*⁴, ¹Mobarak Andish, ²University of Tehran, ³University of Yasoudj, ⁴Telavang Co..

Abstract. This experiment was conducted to investigate the effects of an early skip-a-day feeding program on broiler chickens. The 720 day-old, mixed sex Ross chicks were fed a mash corn diet for the first 36 hrs and

then fed with a conventional starter diet (3089 Kcal ME/Kg and 21.45% CP) until 7 day of age. At this age, 4 floor pen of 30 birds each were randomly assigned to one of 6 dietary treatments. Treatment 1, control, involved in ad lib access to feed and the remaining treatments were subjected to a skip-a-day regimen from 7 to 13 days of age. During the restriction period, the restricted groups had access to water containing 2% sucrose. Starting day 14 to 21, chicks of 6 treatment groups were fed isocaloric diet containing of 20.45, 21.45, 25.27, or 31% CP. From 22 to 42 and 43 to 46 day of age all the treatments received commercial grower and finisher mash diet with 3090 Kcal ME/Kg, 19.32% CP and 3090 Kcal ME/Kg, 17.2% CP respectively. During the restriction period, weight gain of the restricted group was severely affected ($P < 0.05$). Body weight gain over the 33 day of realimentation, was faster for the 21.45% CP treatment that resulted in compensatory growth. As expected, chicks that were subjected to skip-a-day feeding consumed less feed ($P < 0.05$) compared with the control group. Likewise, their overall feed intake throughout the experimental period were also less than ad lib group ($P < 0.05$). The feed conversion ratio of restricted chicks was greater during skip-a-day feeding period than that of control. On the contrary, their FE were significantly better ($P < 0.05$) during the re-feeding period. Overall FE for skip-a-day group was not statistically different than ad-lib. group ($P > 0.05$). At the end of study, GI tract weights of restricted chicks were not different from those of control ($P > 0.05$). Mortality and leg abnormality in this experiment were little so, statistical analysis was not performed on these data.

Key Words: Skip-a-day, Broiler, Compensatory Growth

1670 The effect of dietary 1,4-diaminobutane (putrescine) on the performance and gastrointestinal development of broiler chicks. F.A. Santoyo* and T.K. Smith, *University of Guelph, Guelph, Ontario, Canada.*

The mammalian polyamines: putrescine, spermidine and spermine, are thought to be important promoters of cell division, protein synthesis and cell growth. Protein, DNA and protein:DNA ratio reflect cell size and development and can be used as an index of chick intestinal growth rate. A total of 216 six day-old broiler chicks were fed corn and soybean meal-based diets containing 0, 0.1, 0.2, 0.3, 0.4 and 0.5% supplemental dietary putrescine (6 pens of 6 birds per diet) for 21 days. Feed consumption and growth ratio were determined weekly. At the end of the experiment, 12 birds fed each diet were killed and intestinal sections, liver, spleen and pancreas were excised and weighed and intestinal concentration of soluble protein and DNA were determined. Increasing dietary putrescine resulted in a significant quadratic response in average daily gain, which peaked with the feeding of 0.1% putrescine. The feeding of 0.5% putrescine was clearly toxic. Relative organ weights were not affected by diet. There was a significant linear correlation between duodenal soluble protein concentration and dietary putrescine concentration. Intestinal DNA concentrations were not affected by diet. It was concluded that dietary putrescine supplemented may promote duodenal development in broiler chicks but causes increased growth only when 0.1% supplemented putrescine is fed.

Key Words: Putrescine, Gastrointestinal tract, Protein:DNA

1671 Effects of dietary supplemental Betaglucon on performance and blood components of broiler chicks. S. H. Kim*¹, S. J. Lee¹, K. H. Jung², D. J. Yu¹, S. Y. Park³, J. C. Na¹, and K. S. Ryu³, ¹National Livestock Research Institute of Rural Development Administration, Daejeon, ²Dawmajin biotech, Daejeon, ³Dept. of Animal Resources and Biotech., Chonbuk National University, Chonju, Republic of Korea .

An experiment was conducted to investigate the dietary supplemental betaglucon on performance and intestinal microflora of broiler chicks. Three hundred sixty one day old broiler chicks were randomly replaced into floor pen with four treatments. Four levels of betaglu^R (0, 0.05, 0.1, 0.2%) were added to basal diets. Weight gain, feed intake and feed conversion (FC) were measured for five weeks. Intestinal microflora was examined at third and fifth weeks old. Blood was collected from wing vein at three and five weeks old. Weight gain was no different for the first three weeks, but was significantly increased in 0.1 and 0.2% treatments for the rest two weeks compared to that of control ($P < 0.05$). Feed intake was no different of all treatments. FC of chicks fed 0.1 and 0.2% betaglu^R tended to improve but was not significantly different. No difference were found in *lactobacillus* spp., yeast, *salmonella* spp., *E. coli*

at three and five weeks old. Blood glucose, total protein, AST, ALT, cholesterol, urease, creatinin, Ca, Mg and P showed no difference of all treatments. Triglyceride, GPT, BUN, bilirubin and LDH were prone to increase in 0.1 and 0.2% betaglu^R treatments.

Key Words: Betaglucon, Broiler chicks, Blood components

1672 Influence of feeding *lactobacillus*, live yeast and its combination on the performance and intestinal microflora of laying hens. S. H. Kim*¹, S. J. Lee¹, D. J. Yu¹, S. Y. Park², J. C. Na¹, C. H. Choi¹, and K. S. Ryu², ¹National Livestock Research Institute of Rural Development Administration, Daejeon, ²Dept. of Animal Resources and Biotech., Chonbuk National University, Chonju, Republic of Korea.

A feeding trial was conducted to evaluate the influence of feeding *lactobacillus*, live yeast (Y) and its mixture (L+Y) on the performance and intestinal microflora of laying hens. Two hundred forty Isa brown hens were randomly allocated to six treatments. Control (no supplement), *Pichia farinosa* (Y), *lactobacillus crispatus* avihen1 (LC), *lactobacillus vaginalis* avihen2 (LV) isolated from hen's cecum, LC + Y, LV + Y were supplemented at 0.3% from 21 to 30 weeks of age (WOA). Viable microflora were added to meet 10^6 cfu *lactobacillus*/g Y and 10^7 cfu *lactobacillus*/g of feed. Egg production, egg weight, feed intake, feed conversion (FC) and egg qualities were periodically measured. Intestinal microflora and Fecal NH₃ emission were examined at the end of experiment. Egg production and daily egg mass of birds fed either of the microorganisms alone or in combination were significantly higher than control ($P < 0.05$). Egg production and daily egg mass was especially in birds fed the Y diet. Egg weight and feed intake were not significantly different between treatments. FC improved in Y, LC, Y + LC treatments significantly compared to that of other treatments ($P < 0.05$). Eggshell quality of all treatments was similar except Y treatment. Total *lactobacillus* spp. and anaerobes of ileum seemed to increase greater in LV, LV + Y, LC + Y than others. Total number of ileal and cecal yeast, anaerobes and *lactobacillus* spp. were constant from one to five WOA. Fecal NH₃ emission was significantly lower in LV, LV + Y and LC + Y than other treatments ($P < 0.05$).

Key Words: Laying hens, *Lactobacillus*, Yeast

1673 Influence of feeding various *lactobacillus* on performance and intestinal microflora of laying hens. S. J. Lee¹, S. H. Kim*¹, S. Y. Park², D. J. Yu¹, B. S. Kang¹, J. C. Na¹, C. H. Choi¹, and K. S. Ryu², ¹National Livestock Research Institute, Rural Development Administration, Daejeon, ²Dept. of Animal Resources and Biotechnology., Chonbuk National University, Chonju, Republic of Korea.

The objective of this experiment was to investigate the influence of feeding various *lactobacillus* on performance, intestinal microflora and fecal NH₃ gas emission of laying hens. Three hundred sixty Isa Brown hens were raised with nine treatments of four replicates from twenty one to thirty two weeks of age(WOA). Treatments consisted of control, *Lactobacillus crispatus* avibro1, *Lactobacillus reuteri* avibro2, *Lactobacillus crispatus* avihen1, *Lactobacillus vaginalis* avihen2 at the levels of 10^4 and 10^7 cfu/g diets. Egg production, feed intake, egg weight and feed conversion (FC) were measured every four weeks. Egg qualities, intestinal microflora and fecal NH₃ gas emission were examined at the end of experiment. All *Lactobacillus* supplementation increased egg production and daily egg mass significantly compared to those of control ($P < 0.05$), but were not statistically different between supplemental groups. Egg weight and feed intake also were not different between treatments. FC of birds fed *Lactobacillus* was significantly improved relative that of control ($P < 0.05$). Eggshell breaking strength, thickness, density and Haugh unit were not significantly different. Total number of *Lactobacillus* spp. in the *Lactobacillus* supplemented group was significantly higher than control ($P < 0.05$) in the ileum, but was not significantly different in the cecum. Total yeast and anaerobe numbers of both the ileum and cecum were not significantly different. Fecal NH₃ gas emission was significantly decreased in *Lactobacillus* supplemented groups ($P < 0.05$) and showed no significant difference between 10^7 and 10^4 cfu/g diets.

Key Words: Laying hens, *Lactobacillus*, Performance

1674 Influence of dietary supplemental live yeast on performance of laying hens. S. J. Lee*¹, S. H. Kim¹, S. Y. Park², D. J. Yu¹, J. C. Na¹, C. H. Choi¹, and K. S. Ryu², ¹National Livestock Research Institute, Rural Development Administration, Daejeon, ²Dept. of Animal Resources and Biotech., Chonbuk National University, Chonju, Republic of Korea.

A feeding trial was conducted to evaluate the influence of live yeast supplementation on performance and intestinal microflora of laying hens. One hundred sixty Isa brown hens were individually placed into wire cage with four replicates from twenty one to 30 weeks of age (WOA). Yeast was supplemented at 0, 0.1, 0.3, 0.5% corn-soy based diets containing 2800 kcal/kg ME and 16% CP. Egg production, egg weight, feed intake and feed conversion (FC) were measured. Egg qualities were examined at fifth and ninth weeks. Intestinal microflora, nutrient digestibility and fecal NH₃ were observed at the end of experiment. Egg production of birds fed 0.1 and 0.3% yeast was significantly higher than control and 0.5% yeast supplements (P<0.05). Daily egg mass of 0.3% supplemental groups was significantly increased compared to that of control (P<0.05). The average egg weight was not different. FC was significantly improved as dietary supplemental yeast increased (P<0.05). There were no significant differences in eggshell breaking strength, thickness, density and Haugh units at both 26 and 30 WOA. Viable *Lactobacillus* spp. in the ileum were significantly increased in supplemental yeast groups (P<0.05). However, total number of yeast and anaerobes were similar between the yeast supplemented and control groups. Total *Lactobacillus* spp. and yeast showed no difference in cecum of all treatments. Fecal NH₃ gas emission of birds fed yeast supplementation tended to decrease compared to that of control.

Key Words: Laying hens, Yeast, Performance

1675 Influence of dietary supplemental various *lactobacillus* on performance and fecal noxious gas of broiler chicks. S. H. Kim*, S. J. Lee, D. J. Yu, J. C. Na, S. Y. Park¹, C. H. Choi, and K. S. Ryu¹, National Livestock Research Institute, Rural Development Administration, Daejeon, ¹Dept. of Animal Resources and Biotech. Chonbuk National University Republic of Korea.

The objective of this study was to investigate the influence of feeding various *lactobacillus* isolated from broiler and laying hens on fecal noxious gas and performance of broiler chicks. One thousand eighty one day old male broiler chicks were fed control, *lactobacillus crispatus* avibro1(LCB), *lactobacillus reuteri* avibro2(LRB), *lactobacillus crispatus* avihen1(LCH) or *lactobacillus vaginalis* avihen2(LVH) at the level of 10⁴ and 10⁷ cfu/g diet for five weeks. There were four replicates with thirty chicks per pen. Diets contained 3,100 kcal ME/kg diet and 22.0 20.0% CP for starting and finishing periods, respectively. Weight gain, feed intake, feed conversion (FC), and intestinal microflora were measured weekly. Nutrient digestibility and fecal noxious gas were examined at the end of experiment. Weight gain of chicks fed *lactobacillus* tended to increase and were significantly higher than control at five weeks of age (P<0.05). Feed intake and FC were not statistically different between *lactobacillus* treatments and control. Total *lactobacillus* spp. of birds fed various *lactobacillus* was significantly increased in the ileum at five weeks of age (P<0.05), but was not different in the cecum. The number of total yeast began to increase significantly in cecum and ileum from three weeks (P<0.05), whereas total number of anaerobes tended to increase at both intestine from one weeks of age. Litter moisture of chicks fed *lactobacillus* was ranged from 27 to 30%, but was 38.3% in control. It decreased approximate 25% significantly in *lactobacillus* treatments compared to that of control (P<0.05). Fecal NH₃ gas emission was significantly decrease in *lactobacillus* treatments (P<0.05). Dry Matter(DM), protein and Ca digestibility tended to be higher in *lactobacillus* treatments than control. Ca and P digestibility of chicks fed LCH showed significantly higher than control (P<0.05). Crude ash and fat digestibility tended to improve in *lactobacillus* treatments. In conclusion, feeding various *lactobacillus* improved the performance and reduced fecal noxious gas. The results of this experiment indicated that optimum *lactobacillus* was thought to be more than 10⁴ cfu/g diet.

Key Words: Broiler Chicks, *Lactobacillus*, Performance

1676 A comparison of feeding *lactobacillus* and Virginiamycin influence on performance and intestinal microflora of broiler chicks. S. H. Kim*, S. J. Lee, S. Y. Park¹, D. J. Yu, B. S. Kang, C. H. Choi, and K. S. Ryu¹, National Livestock Research Institute, Rural Development Administration, Daejeon, ¹Dept. of Animal Resources and Biotechnology. Chonbuk National University, Chonju, Republic of Korea.

This experiment was conducted to investigate the effect of feeding two types of *lactobacilli* and Virginiamycin on performance, nutrients digestibility and intestinal microflora of broiler chicks. Seven hundred twenty one day old male broiler chicks (Abor Acres X Abor Acres) were randomly allocated into six treatments with four replications for five weeks. Control (no supplement), 0.5% Virginiamycin (VM), *lactobacillus crispatus* (LC), *lactobacillus reuteri* (LR), LC + 0.5% VM and LR + 0.5% VM were supplemented into basal diets, which contained ME 3,100 kcal/kg and CP 22.0, 20.0% for starting and finishing period, respectively. Weight gain, feed intake and feed conversion (FC) were weekly measured. Nutrients digestibility, intestinal microflora and fecal noxious gas were examined at the end of experiment. Weight gain of chicks fed *lactobacillus* or VM was significantly higher than control (P<0.05). Feed intake increased significantly in those supplemental groups (P<0.05). FC of chicks fed *lactobacillus* or VM was significantly lower than control (P<0.05). Digestibilities of crude protein, calcium, and phosphorus improved significantly in alone or combined *lactobacillus* treatments (P<0.05), Whereas DM, crude fat and ash digestibility were not statistically different. Feeding *lactobacilli* tended to increase the total *lactobacillus* spp. in ileum at one and three weeks of age (WOA) and showed significantly higher in cecum than control at 5 WOA. Total yeast were not shown difference at 1 and 3 WOA, but significantly increased at five WOA (P<0.05). The ileal and cecal anaerobes were started to increase from the first WOA. Fecal NH₃ gas tended to decrease in *lactobacillus* treatments compared to that of other treatments.

Key Words: Broiler Chicks, *Lactobacillus*, Virginiamycin

1677 Survivability of "pelletable" strain of lactic acid producing bacteria in the new direct-fed microbial, Avi-LutionTM, in broiler diets and resulting changes in intestinal and cecal microflora associated with enhanced performance. D. M. Hooge*¹, J. R. Corley², D. Spangler³, P. Brown³, M. D. Sims⁴, and G. F. Mathis⁵, ¹Hooge Consulting Service, Inc., Eagle Mountain, UT, ²Prince Agri Products, Inc., Quincy, IL, ³Agri-King, Inc., Fulton, IL, ⁴Virginia Scientific Research, Inc., Harrisonburg, VA, ⁵Southern Poultry Research, Inc., Athens, GA.

Four broiler chicken pen trials (see also Sims *et al.*, Poultry Sci. 79(Supplement 1):126 and Hooge *et al.*, 2001, abstract 38, IPSF, Atlanta) were conducted in which post-pelleting survivability of the steam heat-stable strain of lactic acid producing bacteria in Avi-LutionTM (AVN) was determined. Commercial broiler strains used were straight-run Ross x Ross 308 (trials 1-3), Ross x Cobb (trial 3 also), and Ross x Arbor Acres (trial 4). The built-up litter pen trials varied in length from a minimum of 42 days to a maximum of 56 days during several different seasons of the year. Stocking density in three broiler tests was 0.062 m²/bird (Virginia) and in the fourth study 0.086 m²/bird (Georgia). In experiments 1, 2, and 4, a basal-control (non-medicated basal diets), an antibiotic-control (bacitracin-md in one test, and virginiamycin in two others), and AVN treatments (0.025, 0.05, 0.075%, or combination step-down program) were examined. In trial 3 with two strains of broilers, only an antibiotic-control treatment (bacitracin-md, then oxytetracycline) was investigated vs AVN using the 0.075, 0.025, 0.025% three phase, step-down program. Improvements (P<0.05) in weight and feed conversion ratio were demonstrated with AVN vs basal-controls and in some instances vs antibiotic-control diets as well. By microbial analysis of lumen contents of market-age broiler intestines (4 trials) and ceca (1 trial), it was found that AVN treatments in one or more cases significantly (P<0.05) lowered coliforms, Campylobacter, Clostridia, and Salmonella, and raised lactic acid bacteria (log cfu/g dry matter) vs basal-control or antibiotic-control diets. The direct-fed microbial was added at the mixer, and all feeds were steam pelleted (starter crumbled). The AVN 0.05% level provided 330 million microbes/kg complete feed. Based on 28 different samples of feed from the trials, survivability of AVN microbes through pelleting was 95.94% (range, 74.67 to 136.97%) by averaging study sample percentages, or 94.68% by dividing overall average recovered microbes by average theoretical number added (x 100

for %). The AVN survived pelleting and beneficially influenced intestinal and cecal microflora populations, accompanied by improvements in broiler growth and feed conversion similar or higher in magnitude to those achieved with antibiotics.

Key Words: Avi-Lution, Direct-fed microbial, Intestinal microflora

1678 Effect of *Aspergillus* sp and bacterial phytase containing broiler diets on *Salmonella enteritidis* organ invasion in the broiler chick. G Nava*¹, N Ledesma¹, A Priego², C Priego², L Sutton³, and G Tellez¹, ¹Departamento de Produccion Animal: Aves, Facultad de Medicina Veterinaria y Zootecnia, UNAM-Mxico, ²Productos Quimicos-Agropecuarios S.A. de C.V. Mexico, ³PetAg Inc, Hampshire, IL 60140 USA.

In the mature broiler the intestinal microflora (IM) is active in reducing the potential for many intestinal diseases. In the neonatal broiler chick, the IM is not sufficiently developed to offer sufficient protection from potential pathogenic invasion. Both enzyme (bacterial phytase) and prebiotic (*Aspergillus* sp) have been used to improve the IM of the broiler and enhance performance. A trial was conducted to determine the effects of adding 0.2% prebiotic, 0.04% enzyme and the combination on *Salmonella enteritidis* (SE) organ invasion in the broiler chick. This experiment employed a completely randomized design. All of the sorghum plus soybean (S/S) diets were isocaloric and isonitrogenous and consisted of four diets with two replicates of 30 birds each (n = 240). The four experimental diets were: 1). Control S/S diet; 2). Control plus prebiotic; 3). Control plus enzyme; and 4). Control plus prebiotic and enzyme. On day 9 and 19, ten broiler chicks from each diet were challenged with 10⁸ CFU of SE. 24 hours post challenge liver and spleen tissues were collected aseptically and incubated for 24 hours at 37 C in tetrathionate enrichment broth. After incubation, the broth was streaked onto brilliant green agar plates, incubated for an additional 24 hours at 37 C, and examined for the presence of lactose-negative, SE colonies. The percentage of cecal tonsils invasion for SE at days 10 and 20 were virtually 100% confirming uniform inoculation with SE. The effects of the dietary additions (prebiotic and enzyme) significantly reduced subsequent liver and spleen SE invasion at days 10 and 20. The SE invasion of liver and spleen tissues in the 10 day-old chick was: 100, 55**, 60**and 80* percent for diet one through four, respectively (*P<0.05, **P<0.01). The SE invasion of liver and spleen tissues in the 10 day-old chick was: 80, 40**, 45**and 65* percent for diet one through four, respectively (*P<0.05, **P<0.01). The dietary addition of both the prebiotic and the enzyme demonstrated similar effects to "probiotics" in the improvement of the IM maturity to resist SE organ invasion in broiler chicks.

Key Words: Apeergillus meal, Phytase, Salmonella enteritidis

1679 Energy and lysine for broilers from 44 to 55 days of age. O. M. Junqueira*¹, L. F. Araujo¹, C. S. S. Araujo¹, D. E. Faria², and N. K. Sakomura¹, ¹Universidade Estadual Paulista - UNESP/Jaboticabal - SP - Brazil, ²Faculdade de Zootecnia e Engenharia de Alimentos - USP/ Pirassununga - SP - Brazil.

One experiment was conducted to evaluate the performance and carcass yield of broilers at 55 days of age fed diets with different levels of metabolizable energy and lysine. Data from performance were weight gain, feed intake, energy intake, lysine intake, caloric conversion and feed conversion. For carcass, it was used data from output carcass, breast weight, wings (wing and over wing), legs (thigh and drumstick), back, head + neck, foot and abdominal fat. The experimental design was a factorial 3x3, involving 3 levels of metabolizable energy (3,200; 3,400 and 3,600 kcal ME/kg and 3 lysine levels (0.95%; 1.05% and 1.15%). No interaction was found between the two factors. Nevertheless, increasing the levels of metabolizable energy resulted in improvement of weight gain (745g; 841 g and 910 g, respectively) and feed intake was found to be higher in broilers receiving the diets with 3,200 and 3,600 kcal ME/kg. Overall performance was not affected by the lysine levels. The feed conversion values were: 2.69, 2.42 and 2.14 from diets with 3,200, 3,400 and 3,600 kcal ME/kg, respectively. Carcass and breast yields were increased with the increment of energy and lysine in the diets. Acknowledgements: FAPESP for financial and technical support Proc. 97/03561-9.

Key Words: Broilers, Lysine, Metabolizable Energy

1680 Dietary supplementation of a blend of galactosidase, galactomannanase and amylase(Endopower[®]) improves energy utilization and intestinal development in broilers. C.W. Kang*¹, S.K. Kim¹, I.H. Chang¹, S.K. Kwan¹, and B.J. Jang², ¹Konkuk University, Department of Animal Science, ²College of Veterinary Medicine.

An experiment was conducted to investigate influences of a multi-enzyme complex compound(Endopower[®]) supplementation to corn-soybean meal diet on energy utilization and intestinal development in broiler chicks. Endopower[®] is a feed grade enzyme blend of α -galactosidase, galactomannanase and α -amylase designed for corn-soybean meal diet. Three hundred sixty 3 d old male broiler chicks(Ross) were randomly housed in 12 pens in an environmentally controlled room and assigned to 4 treatments applying a 2x2 factorial arrangement of two energy levels(3100 and 2980 kcal TME_n/kg diet) with 0 or 0.1% of Endopower[®] in the diet. There were no significant differences in feed intake or feed conversion among the treatments. The enzyme supplementation resulted in greater body weight gain(P<0.05) in the lower energy diet group, indicating the enzyme was very effective in improving energy utilization. However, the birds fed the high energy diet with 0.1% Endopower[®] did not produce additional weight gains compared to the birds fed the high energy without the enzyme diet. The enzyme supplementation reduced relative abdominal fat weights(% BW). The relative intestinal length(cm/BW) of the low energy without Endopower[®] diet group was lower than those of the others. Although the relative weights of jejunum and ileum(% BW) were similar, the duodenum weights(% BW) of the high energy groups were heavier than those of the low ones. The villi of birds fed the diets without Endopower[®] were shortened and thickened compared to those of 0.1% Endopower diet groups regardless of energy level. The results demonstrated that dietary Endopower[®] improved energy utilization and intestinal development and reduced abdominal fats in broiler chicks.

Key Words: Endopower[®] Enzyme, Energy, Intestinal Villus

1681 Effect of Kemzyme[®] on apparent metabolizable energy and ileal digestible energy of wheat and barley samples with differing AME values in broiler chickens. R. R. Carter*¹ and V. Ravindran², ¹Kemin Industries (Asia) Pte Limited, Hornsby, NSW, Australia, ²Massey University, Palmerston North, New Zealand.

This study assessed the impact of dose rate of a xylanase/ β -glucanase based liquid enzyme (Kemzyme[®]) on the apparent metabolizable energy (AME) and ileal digestible energy (IDE) of two wheat samples and two barley samples from different geographical origin during 1999/2000 harvest season. A total of 196 male Ross broiler chicks of uniform body weight were used and distributed into 48 groups (pens) of four birds each. Assay diets contained 95.9% of the test grain and were supplemented with 150 or 200 g/t of enzyme. Each diet was fed to four pens for seven days from day 25 post-hatching. Total collection of excreta was carried out for AME determinations and chromic oxide marker was used for the calculation of IDE. The AME of wheat A was increased from 12.55 MJ/kg DM to 13.56 (+8%) and 13.81 MJ/kg DM (+10%) with 150 g/t and 200 g/t of Kemzyme[®], respectively, while wheat B was increased from 10.8 MJ/kg DM to 13.48 (+25%) and 13.15 MJ/kg DM (+22%). The IDE of wheat A was increased from 12.01 MJ/kg DM to 12.93 (+8%) and 13.14 MJ/kg DM (+9%) with 150 and 200 g/t of Kemzyme[®], respectively, while wheat B was increased from 10.05 MJ/kg DM to 12.46 (+24%) and 12.48 MJ/kg DM (+24%). Significant effects were observed for grain origin (p<0.05) and enzyme addition (p<0.001). The AME of barley A was changed from 12.98 MJ/kg DM to 13.34 (+3%) and 12.91 MJ/kg DM for 150 and 200 g/t of Kemzyme[®], respectively, while barley B was increased from 10.92 MJ/kg DM to 12.17 (+11%) and 11.92 MJ/kg DM (+9%). The IDE of barley A was increased from 11.33 MJ/kg DM to 11.88 (+5%) and 11.83 MJ/kg DM (+4%) with 150 and 200 g/t of Kemzyme[®], respectively, while barley B was increased from 9.8 MJ/kg DM to 10.82 (+11%) and 10.79 MJ/kg DM (+10%). Significant effects were observed for grain origin (p<0.001) and enzyme addition (p<0.05). In summary, Kemzyme[®] significantly increased the cereal AME and IDE values with the greatest AME response associated with lower energy grains. No advantage was recorded from the higher enzyme dose rate.

Key Words: Digestibility, Enzyme, Small grains

1682 **Kemzyme C/S[®] brand for broilers supplementation and its effects on commercial broiler performance.** L. Lewis, A. Lamptey, M. Smith, J. Murphy, and P. A. Welch*, *Kemin Americas, Inc.*

This study evaluated the use of a corn/soybean meal enzyme product, KEMZYME C/S[®] brand for Broilers (KCS), on 49 day broiler performance and yield in a commercial setting. Twenty-eight hundred and eighty Cobb x Cobb male and female broiler chicks were randomly assigned and reared separately, in 48 floor pens. Chicks were allowed ad libitum access to feed and water. All birds received starter diets from d 1-15, grower diets from d 16-29, and withdrawal diets from d 30-49. Diets consisted of corn, soybean meal, meat and bone meal (5%), poultry fat, minerals, and vitamins to meet nutrient requirements for each stage of growth. Treatment diets were either unsupplemented control or KCS enzyme supplemented at 125g/tonne. Enzyme was applied using an AGR International (AGR) post-pelleting system. Dose post-pelleting was verified; however, final active concentration may have been affected by processing conditions. Birds and residual feed were weighed at 49 days and yield determinations were made the following day. No significant differences in weight (avg. 2.23 kg), feed conversion (avg. 1.84) or mortality (3.65%) were observed between enzyme supplemented and control treatments. A subpopulation of birds was randomly selected for yield determinations: liveweight (avg. 2.43 kg), front halves (avg. 37.26%), pectoralis major (avg. 14.51%), pectoralis minor (avg. 3.32%), and wings (avg. 7.93%) were not affected by treatment for either male or female birds. Combined and female WOG and hind half were not affected by enzyme supplementation. However, WOG and hind half yield was improved by 0.84% and 0.48%, respectively, for KCS supplemented male broilers. Although soybean meal concentration in diets was diluted by meat and bone meal, economically viable yield enhancements were detected due to supplementation with KEMZYME C/S[®] brand for Broilers .

Key Words: Enzyme, Corn Soy Diets, Meat Yield

1683 **Release of water insoluble arabinoxylans from rye bran by ferulic acid esterase and pancreatin.** Z. Zhang*, R. R. Marquardt, and W. Guenter, *Department of Animal Science, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2.*

Arabinoxylans crosslink with protein through ferulic acid (FA) to form a complex water insoluble structure of cell wall in rye or wheat grain. Many studies have indicated that the release of water insoluble arabinoxylans (WIA) by non-starch polysaccharide enzymes in the animal gut is associated with an enhanced digestibility of nutrients in the grains. The objectives of this study were to determine (1) if rye bran could be used as a model material for selecting enzymes that are able to open the cell wall structure, and (2) whether ferulic acid esterase (FAE) and pancreatin (PC), a preparation high in proteases, could release WIA from rye bran in vitro. Three studies were carried out. In the first study, rye bran was subjected to treatment with FAE and PC. The results demonstrated that these enzymes enhanced the release of total pentoses from rye bran. Moreover, the log viscosity of the extraction solutions was significantly increased following PC treatment (1.23 times, $P < 0.05$) but was significantly decreased by the FAE treatment (3 times, $P < 0.05$). This latter effect was attributed to the presence of xylanase activity in FAE preparation. The results also showed that the increased viscosity induced by PC could be dramatically reduced by xylanase, but not β -glucanase or PC, and that FAE enhanced the release of ferulic acid into the media. Overall, these studies demonstrated that (1) both arabinoxylans and FA were released by FAE, and (2) that arabinoxylans were also released by PC. Collectively, these results suggest that endogenous enzymes can interact synergistically with other exogenous enzymes to open the structure of the cell wall of cereal grains in the animal gut, thereby facilitating digestion of nutrients such as protein and starch. In addition, these studies also suggest that the bran of grains can be used in conjunction with certain specific enzymes as a model system for studying the mechanism by which enzymes digest cell wall material.

Key Words: Water Insoluble Arabinoxylans, Exogenous and Endogenous Enzymes, Rye Bran

1684 **Prediction of wheat viscosity by near infrared spectroscopy and development of AviNIR calibration.** J. V. Holm¹ and M. Hruby*², ¹*Danisco Cultor, Brabrand, Denmark,* ²*Finnfeeds Int. Ltd, Marlborough, Wiltshire, United Kingdom.*

Grain quality variation contributes greatly to increased variability in broiler performance. Previous research has shown that wheat viscosity, caused by soluble non-starch polysaccharides, correlates closely with wheat feeding quality in terms of AME and broiler performance. Additionally, carbohydrases (e.g. xylanases, beta-glucanases), through its action on soluble non-starch polysaccharides, reduce grain/diet viscosity. Timely and correct evaluation of wheat quality contributes to prediction of a specific enzyme amount (dose) required for a maximum economic return. Chemical viscosity evaluation method (Avicheck[®]) has been used for some time as a basis for wheat quality evaluation. However, the increase in near infrared spectroscopy (NIR) use in the milling and feeding industry and its potential for a rapid determination of chemical constituents of feed ingredients was a decisive factor to evaluate wheat viscosity also through NIR. In the current study, 700 samples of wheat, collected in Europe, North America and Australia during the harvest years of 1999 and 2000, were used to generate an NIR linear calibration equation for nutritive value of wheat measured through the grain viscosity evaluation. Prediction of viscosity was accurate. Coefficient of determination (r^2) was 0.75 for wheat viscosity. This NIR wheat viscosity calibration (AviNIR) covers wheat samples with viscosity of up to 14 cPs, which is more than 95% of all wheat samples screened by Finnfeeds Int. Ltd. during 1996 and 2000 through the chemical viscosity measurement method. On average, the standard deviation between chemical determination of viscosity and NIR was 1.3 cPs. It is concluded, that NIR can accurately estimate the viscosity value of wheat, which contributes greatly to the nutritive value of this grain.

Key Words: Reflectance Spectroscopy, Wheat, Viscosity

1685 **Cell wall polysaccharidase¹ and proteolytic² enzyme combinations may enhance the *in vitro* carbohydrate and protein hydrolysis from toasted and untoasted soybean meal.** I. Ouhida, J. Galobart*, J.F. Perez, and J. Gasa, *Universidad Autonoma de Barcelona.*

Water insolubles (WI) extracted from untoasted vs. toasted (85 and 125°C) soybean meals, were used as substrates to screen the carbohydrate activity of a number of cell wall degrading enzymes. Soybean meal WI yield was 44 vs. 61 and 68%DM⁻¹ of the original sample showing the decreasing solubility with the heat treatment of proteins (59 vs. 44 and 36%) and carbohydrates (41 vs. 28 and 22%, at 0, 85 and 125°C respectively). Incubations were performed at 40°C for 12h with cellulase, pectinase, and xylanase as single enzymes or each one combined with protease. Despite differences between substrate composition from toasting, no significant differences were observed on the enzymatic hydrolysis. Carbohydrate hydrolysis, measured as free monosaccharides, was significantly higher for pectinase (7-9%) and cellulase (9-12%) than xylanase (4-5%) or protease (2-3%). Simultaneous incubations of cell wall enzymes with protease interacted significantly with pectinase (20-22%) and cellulase (12-16%) but not xylanase (4-5%). Single incubations of pectinase and cellulase showed similar proteolytic activities than protease on toasted-85°C SBM (6.0 and 9.7% vs. 7.0% released amino acids, respectively) and higher than xylanase (1.8%). Simultaneous combination of pectinase or cellulase with protease showed an additive effect on protein hydrolysis (10.4 and 11.7%). *In vitro* results suggest an interesting potential of combining cell wall carbohydrases (pectinase and cellulase) and proteolytic enzymes on the hydrolysis of soybean cell wall polysaccharides and proteins. These findings should be confirmed *in vivo* by cell wall polysaccharidase supplementation. ¹Biopectinase NKP, Biocellulase A Con. and Bioxylanase 10P; ²Bioprotease 120P from Quest International Ireland.

Key Words: Soybean carbohydrates, Enzymes, *In vitro* activities

1686 **Effect of Kemzyme[®] on egg production and economics with prior adjustment of wheat and barley AME levels.** R.R. Carter*¹ and R.J. Hughes², ¹*Kemin Industries (Asia) Pte Limited, Hornsby, NSW, Australia,* ²*Pig and Poultry Production Institute, University of Adelaide, Roseworthy, Australia.*

This study evaluated a xylanase/ β -glucanase based dry enzyme included in a laying hen mash diet at 600 g/t. Hyline laying hens were housed at 5 birds per cage in a thermostatically controlled layer shed with a 16 hour light program. There were 12 replicates per treatment, i.e. 2 adjacent cages containing a total of 10 birds. Birds received the trial

diets from 42 to 50 weeks of age. The wheat and barley levels were fixed at 55% and 15% for both treatments. The wheat and barley AME values were each increased by 6% for the enzyme treated diet from control values of 12.7 and 11.6 MJ/kg DM, respectively. While the diet nutrient specifications for both diets remained the same, the effects of increasing the cereal AME values on the enzyme diet formulation compared with the control diet were: increased wheat brand/pollard from 2.99% to 6.24%, reduced tallow from 2.55% to 0.4%, reduced soybean meal from 7.25% to 6.63%, reduced meat meal from 8.3% to 7.8%, and reduced diet cost by A\$7.29 after including the enzyme cost. Prior feed formulation adjustment for the assumed energy utilization effect of the enzyme resulted in the following non-significant differences ($p \leq 0.05$) in production parameters over the 8 week period. The control versus enzyme treatment results were: 86.5% and 87.9% for eggs/100 hen days, 2.15 and 2.18 for g feed/g egg, 63.2 g and 62.6 g for egg weight. The economic impact on 100,000 laying hens over the 8 week period of the combined egg production (assuming a value of A\$1.20/dz eggs) and feed utilization advantages is A\$9,624.20 due to the inclusion of the enzyme.

Key Words: Enzyme, Small grains, Egg production

1687 Effect of diet metabolizable energy level on performance and energy metabolism of broilers. N.K. Sakomura*, C.B.V. Rabello, F.A. Longo, O.M. Junqueira, K. Watanabe, and K. Pelcia, *UNESP Faculdade de Ciências Agrárias e Veterinárias de Jaboticabal - Sao Paulo - Brasil*.

This study was conducted to evaluate the effect of diet energy level on performance, maintenance energy requirement and efficiency of energy utilization for protein and fat deposition. Two hundred-eighty-eight Ross male broilers aged 21 days were distributed at 3 levels metabolizable energy (ME) (3.050, 3.200 and 3.350 kcal/kg) and 3 feeding levels (*ad libitum*, 75% and 50% of *ad libitum* intake), with 4 replications of 8 birds each. Energy retention in carcass was determined based on body composition at the beginning and end of experimental period. The relationship of ME intake (MEI) and energy retained (ER) was used to determine maintenance energy requirements (MEM), energy efficiency above maintenance (k_g) and energy efficiency for protein (k_p) and fat retention (k_f). In order to determine the MEM and k_g were elaborated the following equations for each ME level: 3.350 ER=87.05+0.66.MEI ($R^2=0.97$), MEM=131.12kcal/kg^{0.75}/day, $k_g=0.66$; 3.200 ER=93.74+0.67.MEI ($R^2=0.97$), MEM=140.96kcal/kg^{0.75}/day, $k_g=0.67$; 3.050 ER=88.65+0.67.MEI ($R^2=0.96$), MEM=131.78kcal/kg^{0.75}/day, $k_g=0.67$. The k_p and k_f for each ME level were determined by the slope inversion of the equations: 3.350 MEI=81.34+0.816.REF+2.909.REP ($R^2=0.97$), $k_f=1.23$ and $k_p=0.34$; 3.200 MEI=147.15+1.443.REF+1.485.REP ($R^2=0.97$), $k_f=0.69$ and $k_p=0.67$; 3.050 MEI=128.17+1.233.REF + 1.799.REP ($R^2=0.96$), $k_f=0.81$ and $k_p=0.56$; The body weight gain (g) obtained were: 2058a, 2030ab and 1893b, feed conversion: 1.66a, 1.77ab and 1.88b, body fat composition (%): 38.92, 35.31 and 39.21 and breast yield (%): 33.7, 35.0 and 34.2, for 3350, 3200 and 3050 kcal ME, respectively. The 3200 kcal ME level promoted higher k_p and lower k_f and better performance and carcass quality than 3350 and 3050 ME levels of broiler diets from 21 to 42 days old.

Key Words: Energy efficiency, Energy level, Maintenance energy requirements

ASAS/ADSA Breeding and Genetics: Genetic Parameters and Breeding Strategies

1690 Utilization of ultrasound data from designed progeny testing programs for calculation of carcass trait expected progeny differences. D. J. Kemp*¹, W. O. Herring¹, and C. J. Kaiser², ¹University of Missouri, Columbia, ²Eli Lilly and Company, Indianapolis, IN.

Carcass measurements for weight (HCW), ribeye area (LMA), 12-13 rib fat thickness (FAT), and marbling score (MARB), as well as live animal measurements of weight at the time of ultrasound (YWT), ultrasound ribeye area (ULMA), ultrasound 12-13 rib fat thickness (UFAT), and ultrasound predicted percentage ether extract (UEE) were taken on 2855 Angus steers. The average ages for steers at the time of ultrasound and at slaughter were 391 and 443 d, respectively. Genetic and environmental parameters were estimated for all eight traits in a multivariate

1688 Effect of two sources of sodium on performance and electrolyte balance in broilers. Sultan Mahmood*, R. Ahmad, and S. Hassan Raza, *Dept. of Poultry Husbandry, University of Agriculture, Faisalabad, Pakistan*.

Traditionally, sodium chloride is used as source of sodium in poultry rations. Its supplementation demands great care because any imbalance may lead to depressed performance. This study was conducted to compare the effects of sodium chloride and sodium bicarbonate on broilers' performance, nutrient digestibility, chemical composition of meat and blood chemistry. Five experimental rations having 0,25,50,75 and 100 % supplementation from these two sources were prepared and fed to 150-day-old broiler chicks for 42 days in a completely randomized design. The data on feed intake, weight gain, water consumption, feed efficiency and blood chemistry were recorded. The analysis of data revealed that the use sodium chloride increased the water consumption significantly (201 10.5 vs. 179 10.4 ml/bird daily, $p < 0.05$) whereas sodium bicarbonate significantly increased the weight gain (48.14 5.23g/bird/day, $p < 0.05$), improved the efficiency of feed utilization and deposition of calcium and phosphorus in the broilers. The digestibility of protein was significantly better ($p < 0.05$) in the broilers using sodium bicarbonate than those of the groups fed rations supplemented with sodium chloride, however, dry matter and ether extract digestibility remained unaffected due to the treatments. Blood pH was found significantly higher ($p < 0.05$) in the broilers using rations supplemented with sodium bicarbonate. However, sodium and chloride contents of the blood were not affected. It was also observed that sodium bicarbonate favored the calcium deposition in the head of femur whereas the phosphorus contents deposition remained unaffected. None of the treatments exerted any effect on dressing percentage and breast and thigh meat yield.

Key Words: Broiler, Sodium feeding, Nutrient digestibility

1689 The effects of homocysteine on the avian macrophage *In Vitro*. F. McCorkle* and J. Paquette, *Central Michigan University*.

Homocysteine is an amino acid that has been linked with cardiovascular disease when found in high concentrations in the blood of man. This study looked at the effect of homocysteine on avian macrophage functions, using MQ-NCSU cells. All data was analyzed by one-way ANOVA and experiments were done in triplicate. Homocysteine was not toxic to macrophages at concentrations from 1×10^{-6} to 1×10^{-12} M. (88.9% for 10^{-6} M vs 90.4% for controls) Macrophages adherence was significantly reduced at all concentrations tested (130 cells at 10^{-12} M vs 290 cells for controls). The ability of MQ-NCSU macrophages to phagocytize sheep red blood cells (SRBC) and *Escherichia coli* (*E. coli*) was not affected by homocysteine (28.7% at 10^{-12} M vs 27.0% for controls). The average number of particles taken into the macrophages was not affected by homocysteine (1.26 *E. coli* at 10^{-8} M vs 1.24 for controls). Homocysteine was not cytotoxic and although does inhibit adherence, it does not affect phagocytosis of SRBC or *E. coli*.

Key Words: Homocysteine, Macrophage

animal model. In addition to a random animal effect, the model included a fixed effect for contemporary group and a covariate for measurement age. Heritabilities for HCW, LMA, FAT, MARB, YWT, ULMA, UFAT, and UEE were .48, .45, .35, .42, .55, .29, .39, and .51, respectively. Genetic correlations between LMA and ULMA, FAT and UFAT, MARB and UEE, and HCW and YWT were .69, .82, .90, and .96, respectively. Additional estimates were derived from a six trait multivariate animal model, which included all traits except those pertaining to weight. This model included a random animal effect, a fixed effect for contemporary group, as well as covariates for both measurement age and weight. Heritabilities for LMA, FAT, MARB, ULMA, UFAT, and UEE were .36, .39, .40, .17, .38, and .49, respectively. Genetic correlations between LMA and ULMA, FAT and UFAT, and MARB and UEE were .58, .86, and

.94, respectively. The high, positive genetic correlations between carcass and the corresponding real-time ultrasound (RTU) traits indicate that RTU imaging may be feasible as an alternative to carcass data collection in carcass progeny testing programs.

Key Words: Beef cattle, Ultrasound, Genetic parameters

1691 Genetic evaluations based on ultrasound of yearling beef cattle as related to carcass characteristics of commercially produced progeny. C.J.B. Devitt*¹ and J.W. Wilton², ¹Beef Improvement Ontario, Guelph, Canada, ²University of Guelph, Ontario, Canada.

The objective was to define relationships between carcass measures of commercially produced cattle and sire genetic evaluations based on carcass trait ultrasound. Ultrasound measurements of yearling bulls tested in Beef Improvement Ontario (BIO)'s bull evaluation program were used to obtain genetic evaluations in the form of across breed comparisons (ABCs) for longissimus dorsi area, backfat thickness, and intramuscular fat. The BIO-LINK program offered by Beef Improvement Ontario was used to track carcass weight, percent lean yield, and marbling grade on commercial progeny. The ABC and carcass data included 891 progeny from 85 sires of 10 breeds with an ABC for at least one of the following: longissimus dorsi area, backfat thickness, and intramuscular fat. Since intramuscular fat has been measured only more recently, 493 progeny from 58 sires with intramuscular fat ABC were available. All sires had more than 3 progeny with carcass records. Sire ABCs were calculated using a single trait animal model, expressed as an across breed expected progeny difference, on an age constant basis. Accuracy of ABCs averaged 53, 45, and 39, for longissimus dorsi area, backfat, and intramuscular fat, respectively. Correlation using unadjusted progeny carcass data showed that progeny marbling was positively correlated to sire intramuscular fat ABC, at 0.31. Correlations of progeny percent lean yield with sire longissimus dorsi area ABC and sire backfat ABC were .32 and -.40, respectively. Correlations of progeny carcass weight with sire longissimus dorsi area ABC and sire backfat ABC were .31 and -.24, respectively. Regression of progeny marbling on sire intramuscular fat ABC was significant ($P < .01$), as were regressions of progeny carcass weight and percent lean yield on sire longissimus dorsi area and backfat thickness ABC. These results show that carcass measures of commercially produced progeny are significantly related to sire genetic evaluations based on ultrasound.

Key Words: beef cattle, ultrasound, genetic evaluations

1692 Effects of amino acids and calcium levels on radiographic density and calcium excretion in broilers from 43 to 49 days of age. S. M. Baraldi-Artoni¹, C. S. S. Araujo*¹, L. F. Araujo¹, O. M. Junqueira¹, M. J. Q. Louzada², and N. K. Sakomura¹, ¹Universidade Estadual Paulista - UNESP/Jaboticabal, SP - Brazil, ²Universidade Estadual Paulista - UNESP/Araatuba, SP - Brazil.

Male broiler Avian Farms (n=540) were used from 43 to 49 days of age were subjected to a 3x2 factorial design consisting of three levels of dietary amino acids (100,125 and 150% NRC, 1994) and two levels of dietary calcium (75 and 100% NRC, 1994) with a total of 6 treatments replicated three times per treatment. Radiographic density (mm Aluminium equivalent), tibia variables (tibia weight, tibia length, compact bone thickness and spongy bone thickness) and Ca excretion were evaluate. The AA analyzed were methionine, lysine and threonine. Diets and water were available free choice. Experimental diets were comprised primarily of corn and soybean meal and were formulated to be isocaloric and isoproteic. Requirement levels for AA were accomplished when necessary by adding crystalline AA. Total fecal output was collected for 72 h from days 47 to 49 to determine the treatment effect on Ca excretion. Percentage Ca excretion was calculated as grams of Ca in feces divided by grams of Ca consumed in the 72-h period. At 49 days, two broilers from each pen were slaughtered and the tibia left of the birds were collected and analyzed according to radiographic density (mm Aluminium equivalent). The AA or Ca levels unaffected radiographic density, tibia variables and Ca excretion. There were found interactions between the two factors. Acknowledgements: FAPESP for financial and technical support.

Key Words: Amino Acids, Broilers, Calcium

1693 Genetic variation between two tropically adapted *Bos taurus* breeds, the Romosinuano and the Senepol . R. A. Breneman*¹, C. C. Chase, Jr.¹, T. A. Olson², D. G. Riley¹, and S. W. Coleman¹, ¹USDA, ARS, SubTropical Agricultural Research Station (STARS), Brooksville, FL, ²University of Florida, Gainesville.

Twenty-eight microsatellite loci were used to estimate parameters of genetic variation between two tropically adapted *Bos taurus* breeds, the Senepol (n = 47) and the Romosinuano (n = 47), under evaluation at STARS. The Senepol was developed on St. Croix, U. S. V. I., as a cross reported to be between the Red Poll from England and the N'Dama from Senegal. The STARS Senepol herd was acquired through the importation of animals from St. Croix in 1982. The Romosinuano is a criollo breed remnant from the cattle left by the early Spanish missionaries in Colombia. The STARS purebred Romosinuano herd was acquired via embryo importation from Venezuela in 1996. Phenotypically, both are medium-framed breeds, light to medium red in color, polled, and adapted to the hot humid tropical climate of the Caribbean region. Visual phenotypic variation significantly overlaps between the two breeds. Animals from the respective STARS herds were selected by pedigree and sampled as breed representatives. The DNA samples were extracted from isolated buffy coats, amplified by PCR, electrophoresed on 6% polyacrylamide gels, and visualized with silver stain. Allele sizes were estimated relative to a 25 bp DNA stepladder electrophoresed concurrently with the amplified PCR product. Analysis was performed using GENEPOP with alleles coded by three-digit fragment size. Exact Hardy Weinberg tests calculated across all loci support each population to be in Hardy Weinberg Equilibrium ($P < 0.001$). The genetic differentiation detected between the populations was highly significant ($P < 0.001$). The number of effective migrants between populations was negligible ($N_m = 0.325$). The mean frequency of private alleles between the two populations was 0.134. Nei's standard distance (Ds) calculated for the two populations across all loci was 0.825. These population statistics confirm that regardless of phenotypic similarities, these Romosinuano and Senepol populations are distinct and genetically diverse.

Key Words: Beef Breeds, Microsatellites, Genetic Distance

1694 Estimates of genetic and phenotypic parameters of calf birth weight and calving difficulty in Limousin cattle. Adolfo Prez Mrquez¹, Francisco Ponce Medina¹, Juan Rodriguez Garca¹, Fulgencio Bueno Fierro¹, Hctor Gonzlez Garca¹, Abelardo Correa Caldern¹, Juan Guerrero Cruz², and Jess Trejo Castillo³, ¹Universidad Autnoma de Baja California, ²University of California, Davis, Holtville, ³Universidad Autnoma de Ciudad Jurez.

Genetic parameters for birth weight and calving difficulty were evaluated in a herd, located in Samalayuca, a representative rangeland system in the desert region in northern Mexico. Progeny of 41 cows involving inheritance of Limousin (L) mated to sires Limousin were used. The objective was to estimate direct heritabilities for birth weight (BW) and calving difficulty (CD). Separate analyses for each trait used least squares mixed model, SAS (1989). The analytical model included: year of birth, age of dam, sex of the calf, with date of birth as a covariate to adjust a common age as fixed effects; sire and residual as random components. Mean birth weight was 37.97 kg. Birth weight ranged from 36 kg in heifers 29 months old at parturition to 41.4 kg in mature cows 57 months old at parturition. Calving difficulty was subjectively evaluated categorically using descriptive scores (i.e., 1=no difficulty, 2=little difficulty by hand, 3=little difficulty with jack, 4=slight difficulty with a calf jack, 5=moderate difficulty with calf jack, 6=major difficulty with jack, and 7=Caesarean birth presentation). Calving difficulty was greater ($P < .05$) in heifers (17%) than mature cows (9.38%). The sex of the calf was the major source ($P < .05$) of variation in levels of calving difficulty for both heifers and mature cows. The estimated heritability values for birth weight and calving difficulty were .29.07 and .05 .04, respectively. Breeders must consider birth weight and calving difficulty as important traits in their breeding programs.

Key Words: Birth weight, Calving Difficulty, Heritability

1695 Genetic parameters estimates for lean growth rate and its components in U.S. Yorkshire, Duroc, Hampshire, and Landrace pigs. P. Chen*, T.J. Baas, and J.W. Mabry, *Iowa State University, Ames, IA.*

Records on 361,300 Yorkshire, 154,833 Duroc, 99,311 Hampshire, and 71,097 Landrace pigs collected between 1985 and 1999 in herds on the National Swine Registry STAGES program were used to estimate additive genetic (animal), common environmental (litter) and residual variances and covariances for lean growth rate, days to 113 kg, backfat, and loin eye area. Analysis was by the REMLF90 program of I. Misztal using a multiple-trait animal model with fixed effects of contemporary group and sex and random effects of animal, litter, and residual. Estimates of heritabilities were 0.35, 0.40, 0.52, and 0.43 for lean growth rate, 0.43, 0.47, 0.57, and 0.46 for days to 113 kg, 0.35, 0.41, 0.55, and 0.49 for backfat, and 0.44, 0.43, 0.50, and 0.38 for loin eye area in Yorkshire, Duroc, Hampshire, and Landrace, respectively. Genetic correlations were -0.94, -0.86, -0.80, and -0.80 between lean growth rate and days to 113 kg, -0.32, -0.40, -0.25, and -0.41 between lean growth rate and backfat, and 0.40, 0.40, 0.36, and 0.36 between lean growth rate and loin eye area in Yorkshire, Duroc, Hampshire, and Landrace, respectively. Estimates for heritabilities and genetic correlations were consistent across breeds except for higher heritabilities for the Hampshire breed. Estimates for heritabilities across the four breeds for lean growth rate, days to 113 kg, backfat, and loin eye area were 0.43, 0.48, 0.45, and 0.44, respectively. Genetic correlations across the four breeds between lean growth rate and days to 113 kg, backfat, and loin eye area were -0.85, -0.35, and 0.38, respectively. Litter effects were generally small (< 0.1) except 0.12 for both days to 113 kg and loin eye area in the Yorkshire breed. The results indicate that lean growth rate should be used as an important selection criterion in genetic improvement of pigs.

Key Words: Lean Growth Rate, Heritability, Genetic Correlations

1696 Evaluation of Duroc vs. Pietrain sired progeny for meat quality. D. B. Edwards*, R. O. Bates, and W. N. Osburn, *Michigan State University, E. Lansing, MI/USA.*

Novel swine populations may contribute beneficial genes to U.S. swine production systems. Crossbred progeny sired by either Duroc or ryanodine receptor gene normal Pietrain were used in this study. Boars from each breed were mated to Yorkshire or F1 Yorkshire-Landrace females. A total of 162 offspring were evaluated for meat quality. Measurements were taken on animals representative of each litter. Data were analyzed using an animal model with fixed effects of breed of sire, breed of dam, gender, slaughter group, the interaction of breed of sire and gender, and random effect of animal. An additional term of pig was included in the model to fit the within pig variation from sample to sample. Shear force measurements had six samples per pig, while other meat quality measures had two samples per pig. Meat quality measures were not different or favored Duroc sired progeny. Duroc progeny had better subjective meat quality scores (1-5 scale) for color (2.540 vs. 2.354, $P < 0.05$), marbling (2.425 vs. 1.739, $P < 0.001$), and firmness (2.615 vs. 2.295, $P < 0.001$). Furthermore, Duroc progeny had higher 24-h pH (5.526 vs. 5.468, $P < 0.001$) and less percent drip loss (2.892 vs. 3.893, $P < 0.001$). No differences were detected between Duroc and Pietrain sired progeny for Minolta L* (54.764 vs. 55.307), a* (17.348 vs. 17.272), or b* (7.581 vs. 7.441) objective color scores, percent cooking loss (28.629 vs. 29.187), or Warner-Bratzler shear force (6.942 vs. 7.095 kg). Both Duroc and Pietrain populations merit further study into the genetic control of these meat quality traits.

Key Words: pig, meat quality, breeds

1697 Determining inbreeding levels for the Navajo-Churro sheep breed. A. Maiwashe*¹, B. Tseveenjav¹, B. Golden¹, and H. Blackburn², ¹Colorado State University, ²USDA/ARS.

Maintaining genetic diversity in breeds and specifically breeds of small population size requires understanding genetic relationships among animals within a breed. Not knowing such information reduces breeder and association ability to correct situations of genetic erosion and inbreeding. The Navajo Churro is a sheep breed with a small population size and at one time was considered a rare or endangered breed. Therefore, pedigree records from the Navajo Churro Sheep Association were evaluated to determine inbreeding level, rate of inbreeding and the number of flocks with inbreeding. The breed society was formed in 1988; records

collected by the association from 1988 to 1999 were analyzed. There were 2,654 registrations in the analysis. Inbreeding level was calculated using the Animal Breeders Tool Kit. Information concerning inbreeding level and flock size was used as layers in a GIS analysis of the data. Since the formation of the breed society, there have been four generations produced. The average inbreeding for the fourth generation was calculated at 4.6 vs 1.3% for the third generation. Third generation registrations were 360 vs 95 hd for the fourth generation. As the breed moved from the third to the fourth generation, it appears that the rate of inbreeding increased exponentially. Flock inbreeding levels were calculated and it was determined that 32% of the breeders with generation 3 and 4 animals had flock inbreeding levels ranging from 3.1 to 10.5%. Inbreeding levels are increasing among sheep registered with the Navajo-Churro Sheep Association. If inbreeding is left unchecked, and is not intentional, this could develop into a significant problem for this breed.

Key Words: Navajo Churro sheep, Inbreeding, Genetic diversity

1698 Genetic parameters for some growth traits of Local breed of goat in the United Arab Emirates. Salih Al-Shorepy*, Ghaleb Alhadrami, and Khalfan Abdulwahab, *United Arab Emirates University.*

The Local goat breed is the most common native breed of the United Arab Emirates and is adapted to its harsh environment. The data used in the present study was collected from the conservation flock at the Faculty of Agricultural Sciences Experimental Station. The traits recorded were body weights at birth (BWT), 30 days (WT30) and weaning (WWT), and average daily gains from birth to 30 days (ADG1), 30 to 90 days (ADG2) and birth to weaning (ADG3). Season of birth, type of birth or rearing, sex of kid and dam age at kidding were the environmental factors investigated. Genetic parameters and phenotypic and genetic correlations were estimated by REML procedures. By ignoring or including maternal genetic or environmental effects, four different models of analysis were fitted in order to determine the most effective model for each trait. Additive maternal effect was important ($P < 0.05$) for BWT, when compared with a model containing only additive direct effects. Inclusion of maternal permanent environmental effect provided a better fit ($P < 0.05$) for WT30, WWT and ADG1. Estimates of direct heritability from the most appropriate models were 0.18 for BWT, 0.16 for WT30, 0.32 for WWT, 0.11 for ADG1, 0.09 for ADG2 and 0.42 for ADG3. The estimates of genetic and phenotypic correlations were high and showed no genetic antagonisms among growth traits analyzed. It can be concluded that maternal effects have to be accounted for when estimating genetic parameters for BWT, WT30, WWT and ADG1.

Key Words: Local goats, Growth, Genetic parameters

1699 Estimation of heritability and repeatability for superovulatory responses of Japanese Holstein population. Y. Asada*¹ and Y. Terawaki², ¹The Graduate School of Dairy Science, Rakuno Gakuen University, ²Rakuno Gakuen University Dairy Science Institute.

The subjects of this study were to estimate repeatability and heritability for the yield of embryos and transferable embryos in Holstein population in Hokkaido, Japan. Data consisted of 306 MOET treatments on 224 Holstein cows from 1997 to 2000. Data were analyzed to investigate the factors affecting superovulatory responses of Japanese Holstein cows using maximum likelihood method and generalized linear model. Variance components for the superovulatory responses were estimated using REML employing animal model. The mean number of embryos and transferable embryos yielded per flush were 6.7 and 4.4, respectively. A good fit exhibited for negative binomial distribution of number of embryos and transferable embryos yielded. A lack of fit exhibited for Poisson and Binomial distribution of the number of embryos and transferable embryos yielded. Factors identified as importance in affecting superovulatory response were the areas (branch offices) and the donors estrus condition after superovulation for the number of embryos. And for the number of transferable embryos the characteristics of each donor was an important factor in addition to affecting factors for the number of embryos. The estimated heritability and repeatability for the yield of embryos were 0.02 and 0.38, and for the yield of transferable embryos were 0.05 and 0.28, respectively. These results showed that prior to carrying out MOET schemes, the consideration of affecting the areas and the donor's estrus condition after superovulation is need to be taken into account when using a computer simulation to predict the genetic gain

and the rate of inbreeding. The results also showed that it is indispensable to use repeatability of donor's superovulatory responses including the characteristics of each donor, so that the computer simulation can produce the more realistic results.

Key Words: Holstein, heritability, transferable embryo

1700 Genetic correlation between final scores over time in Holsteins. S. Tsuruta^{*1}, I. Misztal¹, L. Klei², and T. J. Lawlor², ¹University of Georgia, Athens, ²Holstein Association USA, Inc., Brattleboro, VT.

The goal of this study was to determine how the definition of final score changes in time. The first conformation final scores for cows born between 1951 and 1997 were obtained from Holstein Association USA Inc.; the number of cows born before 1970 was small. The model contained management group, age group, stage of lactation, and regressions on the year of birth as fixed effects; additive genetic random effects with random regressions on the year of birth using third order Legendre polynomials; and residual effects. Ten datasets, each having about 15,000 records, were randomly sampled from the original complete file (4,595,237 records). Estimates of additive genetic and residual variances were constant over the years (about 4.0 and 9.8, respectively). Genetic correlations between years of birth decreased from 1.0 to 0.7 as the distance between the years increased. These correlations between years 1997 and 1981 were .80 and between years 1951 and 1981 were 0.79; however, due to a small number of records in early years and/or low order polynomials, these correlations may have been under (or over)-estimated. The national genetic evaluation for final score may be more accurate if old scores are discarded or treated as separate traits.

Key Words: Holstein, Conformation final score, Random regression

1701 The genetic relationships among milk yield, herd life and productive life in Holstein cows in Hokkaido, Japan. T. Obayasi^{*1} and Y. Terawaki², ¹The Graduate School of Dairy Science, Rakuno Gakuen University, ²Rakuno Gakuen University Dairy Science Institute.

The objectives of this study were to estimate heritability for milk yield at first calving, lifetime milk yield, herd life and productive life of Holstein cows in Hokkaido, Japan. A total of 1,070,646 herds records of Holstein cows in Hokkaido, Japan, for animals born between 1963 and 1997 were classified into life span groups using three different criteria: less than 36 months; more than 36 months less than 72 months; and more than 72 months. These three groups were termed Group 1, Group 2 and Group 3, respectively. Milk yield at first calving, lifetime milk yield, herd life and productive life were all calculated for each animal. Analysis gave a mean for each trait for each group as follows: Group 1: 5531.3 kg, 2895.3 kg, 163.8 days, and 39.4 days; Group 2: 5506.7 kg, 13832.9 kg, 588.9 days, and 584.3 days; and Group 3: 5265.9 kg, 39149.6 kg, 1535.4 days, and 754.3 days, respectively. In Group 3, animals with a high milk yield at first calving showed a high lifetime milk yield, but herd life and productive life trend to be low. Next, we estimated heritability for each trait (milk yield at first calving, lifetime milk yield, herd life and productive life) in each group using REML F90. Heritability of each trait was estimated for a total number of 2,500 animals. In Group 1 heritability for each trait was found to be 0.32, 0.34, 0.08 and 0.22, respectively. In Group 2, heritability for each treat was found to be 0.34, 0.02, 0.20 and 0.19, respectively. And in Group 3, heritability for each trait was found to be 0.35, 0.01, 0.29 and 0.14, respectively. Animals with a high life span tend to show low heritabilities for lifetime milk yield and productive life. Heritability for herd life, however, was low. Animals with a low life span showed low heritability for herd life. Heritability for milk yield at first calving were similar in each group.

Key Words: Heritability, Longevity, Holstein

1702 Suitability of physiological traits of young cattle for the evaluation of their performance stability. L. Panicke^{*1}, R. Staufenbiel², and E. Fischer³, ¹Research Institute for the Biology of Farm Animals, Dummerstorf, Germany, ²Free University Berlin, Institute of Veterinary Physiology, Germany, ³University Rostock, Faculty of Agricultural and Environmental Sciences, Germany.

High milk performance connected with sound health regarding metabolism and sufficient fertility in dairy cows depends on a well balanced distribution of energy in the body. The concentration of glucose

in the blood is relatively constant. Enzymes, hormones, controlling proteins and transporters contribute to the enormous synthesis production of 3 to 4 kg glucose. These are capable of influencing the efficiency of glucose production and distribution. Glucose and growth hormone as "early predictors" are superior to other possible parameters such as free fat acids, urea, thyroxin, prolactin, somatropin and IGF-1 in comparing the relationship between physiological metabolic parameters and the performance of cows and sires. Insulin plays an outstanding role based on its central position in energy metabolism. The function of insulin may be recorded by means of the intravenous glucose tolerance test (GTT). The reaction of insulin and glucose was investigated after infusion of 1 g glucose per kg^{0.75} because of the probable genetic determination of the reactive ability. The coefficient of heritability was estimated as $h^2=0.28\pm 0.16$. The metabolic reaction for young cattle was the same for females and males as the GTT-parameters basic concentration of glucose was 4.0, 4.2 and 4.1 nmol/l plasma and the glucose half-life was 51.0, 49.2 and 50.3 minutes for heifers (n=22) and young sires (n=20, n=87), respectively. The differences of insulin and glucose show a contrary course and depend on the age under standardized feeding. The correlation between GTT and offspring breeding value (EBV) is also influenced by the age (in half-life years). The best correlation is read at the 3rd half-year. Three independent groups of 24 and 28 young sires and 12 heifers were involved in the investigation. The correlation coefficients between the glucose half-life (GHWZ) and the offspring breeding value (EBV) of about -0.4 to -0.5 are higher compared to the pedigree breeding value (PBV). If the so far achieved results are confirmed, an additional recommendation for the evaluation of breeding bulls before the start of the progeny test could be given. The test capacity could be extended or costs for testing bulls could be lowered.

Key Words: Cattle, Breeding Value, Physiology

1703 Influence of the quality of reproductive event data on heritability of gestation length in DHI herds. W. Zhang^{*} and G. E. Shook, University of Wisconsin, Madison.

Genetic evaluations for reproductive traits in dairy cattle are economically important. Accurate genetic evaluations for these traits depend on accurate recording of reproductive events; recording which is notoriously poor or inconsistent in many herds. In order to measure the quality of reproductive event data, gestation length (GL) was investigated in this study because of its biological consistency, having a standard deviation of 5.8 d and coefficient of variation of only 2% in these data. Although GL is not a trait of economic interest, it can be useful for measuring the accuracy of recording reproductive events in general. Data from Wisconsin Holstein herds during 1992 to 2000 were provided by AgSource Cooperative. Gestation length was calculated as days from last breeding to calving. Normal GL (NGL) was defined as 280 d \pm 21 d. Herds with 60 d non-return rate greater than 90% were excluded. Records that ended in abortion or had calculated GL outside the range 259 to 301 d were omitted. A basic data set with 3,906 herds including 244,222 parities was generated after the above editing. Several herd selection criteria based on within-herd percentage of NGL and/or within-herd standard deviation of GL (SDGL) were used to filter the basic data and eight data sets were created. REML estimation of the heritability (h^2) was performed through sire model for each data set. Heritabilities are in the table below. Compared with the basic data, estimates of h^2 based on selected data sets can be increased by at least 2%. The more stringent selection criteria resulted in higher h^2 . The effect of these data selection criteria on heritabilities for economically important reproductive measures are yet to be determined.

Data	Herd Selection Criteria	Records Retained(%)	Herds Retained(%)	h^2 (%)
1	Basic data set	100	100	13.9
2	SDGL<8 d	99	96	15.6
3	NGL>40%	96	92	16.3
4	SDGL<8 d and NGL>40%	95	88	15.9
5	SDGL<6 d	77	69	16.4
6	NGL>50%	73	64	16.6
7	SDGL<6 d and NGL>50%	59	47	17.3
8	SDGL<5 d and NGL>60%	9	10	20.8

Key Words: Gestation Length, Reproductive Data Quality, Dairy Cattle

1704 Heritabilities and genetic correlations between height, length, weight and body condition score of Holstein heifers in high producing Wisconsin dairy herds. C. D. Dechow*¹, N. C. Dorshorst², P. C. Hoffman², K. A. Weigel², J. Jensen³, and G. W. Rogers¹, ¹*Pennsylvania State University*, ²*University of Wisconsin-Madison*, ³*Danish Institute of Agricultural Research*.

The objectives of this study were to estimate genetic and phenotypic parameters for heifer growth in selected high producing Holstein herds. Height, length, heart girth circumference and body condition score (BCS) of heifers were recorded in 19 Wisconsin dairy herds with rolling herd averages greater than 13,500 kg. Each herd was visited one time. Therefore, measurements were recorded only once per heifer. Body weight was estimated from heart girth measurements. Sire information was available for 1163 heifers from 75 to 800 days old. Heifers were sired by 295 bulls. Heritabilities and correlations were estimated assuming a multiple-trait sire model using Average Information REML. All models included a fixed herd effect, linear and quadratic age covariables, and a random sire effect. Heritability estimates were 0.31, 0.26, 0.32 and 0.14 for height, length, weight and BCS respectively. Genetic correlations were 0.58 between height and length, 0.27 between height and weight, and 0.3 between length and weight. Residual correlations among height, length and weight ranged from 0.23 to 0.39. Genetic correlations between BCS and height, length and weight were -0.39, -0.23 and 0.1 respectively. Residual correlations between BCS and the growth measurements ranged from 0.22 to 0.41. Standard errors for all genetic correlations ranged from 0.22 to 0.4, while residual correlations ranged from 0.08 to 0.1. Heifers that were genetically inclined to grow more rapidly tended to have lower BCS. However, management and environmental conditions that increased growth rate also increased BCS.

Key Words: heifers, growth, heritability

1705 Accuracy of reported birth and calving dates of dairy cattle in the United States. H.D. Norman*, J.L. Edwards, and J.R. Wright, *Animal Improvement Programs Laboratory, Agricultural Research Service, USDA, Beltsville, MD*.

Frequencies of births that were reported for specific days of the month were documented for US dairy cattle born since 1987 by birth year, herd size, and registry status and compared with calving frequencies for those dates. Because birth dates are expected to be random and uniformly distributed throughout each month, percentages of births on individual dates were expected to be equal (3.3% for d 1 through d 28, 3.2% for d 29, 3.0% for d 30, and 1.9% for d 31). However, percentages of reported birth dates for d 1, 2, 10, 15, and 20 were higher than expected. Percentage of reported births for d 1 was highest (5.3%) of all days of the month regardless of herd size or registry status. The nonuniform distribution of birth dates within month indicated that a substantial number of birth dates were unknown and that estimated birth dates had been reported. About 1.5% of birth dates overall appeared to have been estimated. The highest frequencies for birth dates on d 1 (5.9 to 7.4%) were found for registered cows during months that initiated age groupings for dairy shows (March, June, September, and December). Alteration of birth dates to gain an advantage in cattle shows is likely to have occurred. Birth dates for some registered cows were intentionally misreported as confirmed by comparison of birth dates of individual cows with calving dates of their dams. Reported calving dates appeared to be more accurate than reported births; the inflated frequency of recorded calvings on d 1 was only about 30% as large as the inflated frequency of recorded births. Because cow age is determined by birth date, proper reporting of birth dates is important to ensure the accuracy of standardized yield and fitness records and the genetic evaluations that are based on those records. When animals' recorded birth dates and their dams' calving dates differ, more credence should be given to the latter to improve accuracy.

Key Words: Birth date, Calving date, Accuracy

1706 Expected correlated responses for conformation traits, 48 month stayability and milk yield of Mexican Holstein cattle. M Valencia-Posadas¹, F Ruiz-Lopez*², J Moro-Mendez³, and H Montaldo-Valdenegro¹, ¹*Instituto de Ciencias Agrícolas. Universidad de Guanajuato. Guanajuato, Mexico.*, ²*Cent. Nal. de Invest. en Fisiología y Mejoramiento Animal. INIFAP-SAGARPA*, ³*Holstein de Mexico A.C.*

(Co)Variance components were estimated for mature equivalent first lactation milk yield (MY1), 48 month stayability (48ST) and 11 conformation traits: stature (ST), body depth (BD), rump angle (RA), thurl with (TW), foot angle (FA), rear legs side view (RS), bone quality (BQ), fore udder attachment (FU), front teat placement (FT), udder cleft (UC), udder depth (UD) and final score (FS). Mexican Holstein Association's pedigree information and classification system results were used on 3,409 cows. Derivative free REML was used to estimate (co)variance components under an animal model. Heritabilities for MY1 and 48ST were 0.25 and 0.01, respectively. Heritabilities for conformation traits ranged from 0.04 (UD) to 0.34 (ST). Genetic correlations among MY1 and the conformation traits ranged from -0.27 (UD) to 0.48 (UC) while those among 48ST and the conformation traits ranged from -0.30 (BD) to 0.69 (RS). Due to the high genetic correlations found specially between FT (0.40), FS (0.51), UD (0.52), and RS (0.69) with 48ST it could be recommended that these traits are used in selection programs to improve 48ST. Selecting for MY1 alone will improve UC, TW and to a lesser degree RA, since the genetic correlations were 0.48, 0.26, 0.10, respectively. When MY1, 48ST and FS were combined in an index, the optimum genetic advancement was obtained using a 3:1:1 ratio, which resulted in improvements of 739 kg, 0.40 % and 0.87 points per generation, respectively.

Key Words: Correlated responses, stayability, milk yield

1707 The relationship between the estrous situation of donor cows and genetic gain in Japanese Holstein MOET populations. Yoshinori Terawaki*¹ and Yohei Asada², ¹*Rakuno Gakuen University Dairy Science Institute*, ²*Rakuno Gakuen University*.

The relationship between the estrous situation of donor cows and genetic gain in Japanese Holstein MOET (multiple ovulation and embryo transfer) populations was examined using Monte Carlo simulation. The observed data (n = 306) used in this study were from an MOET program that has been carried out in Hokkaido, Japan. The data were divided into three parts, according to the degree of estrus (strong, normal or delicate) of donor cows. For each of those parts, the distribution of the number of transferable embryos collected per flush (NTECPF) was researched. Determination methods, using the Poisson and gamma (alpha = 1.0) distributions, were developed in order to generate the numbers fitting the distribution of NTECPF. The genetic gains and inbreeding coefficients in MOET populations with several different estrous situations were estimated using these determination methods. Four estrous situations, referred to as A, B, C and D, were assumed. Strong, normal and delicate estrus were assumed to occur in the ratio 7:2:1, 5:4:1, 3:6:1 and 1:8:1 in A, B, C and D, respectively. The base population was assumed to be 200 cattle. Ten males and 30 females were selected in each generation. The rates of strong, normal and delicate estrus in the observed data were 33, 58 and 9 %. The generated numbers were best fitted to the distributions on the observed data when beta of the gamma distribution was set at 7.6, 4.4 and 2.6 for strong, normal and delicate estrus, respectively. The mean NTECPF was highest (6.3) in A and lowest (4.6) in D. The frequencies of flushes that collected no transferable embryos were lowest (14.7%) in A and highest (18.7%) in D. For juvenile schemes, the largest genetic gain (5.4 genetic standard deviation unit) in the 10th generation was predicted to occur in C. The genetic gains in A and D were about 5.2 in the 10th generation, and these were the smallest. For adult schemes, the largest genetic gain (8.4) was predicted in A. The mean genetic gains increased as the ratio of strong estrus increased.

Key Words: Genetic gain, Estrous situation, Holstein MOET

1708 Economic weight and selection index with variance of milk yield, herd life, and depreciation cost . Y. Matsuoka*¹ and Y. Terawaki², ¹*The Graduate School of Dairy Science, Rakuno Gakuen Univ.*, ²*Rakuno Gakuen Univ. Dairy Science Institute.*

The goals of this study were to estimate the economic weight of the aggregate breeding value and to create a selection index from the point of view of milk yield and longevity. Aggregate breeding value was defined as $H = aMY \text{ GMY} + aHL \text{ GHL}$. Economic weights were aMY and aHL for milk yields and herd life, respectively. These values were estimated based on the partial derivatives of milk yield and herd life to the derived function which was calculated as the revenue minus cost per year per cow in Hokkaido, Japan. The relative economic weight of milk to herd life was calculated as aMY/aHL . Selection index traits were actual milk yield and four body traits—mammary system, angularity, rear udder height and udder support—for herd life at 48, 60, and 72 months. Therefore, the selection index was $I = bMY \text{ pMY} + bMS \text{ pMS} + bAG \text{ pAG} + bUH \text{ pUH} + bUS \text{ pUS}$. In these analyses, milk yield, herd life, and depreciation cost were changed from -60 to 60 percent. With change in the milk yields, aMY decreased, aHL increased to 6,400kg of milk, after which it showed a decrease. Both aMY and aHL decreased with the change in herd life, whereas they increased with the change in depreciation cost. The two curves of the relative economic weight of milk to adjusted herd life with the change in milk yield and the depreciation cost change were similar; the relative economic weight decreased within the range of approximately from 3 to 12 as the percentage increased. With the change in herd life, the tendency of the relative economic weight differed from the change in milk yields and depreciation cost change, while the relative economic weight increased within the range of approximately from 1 to 12. Each tendency of the weighting factors of the selection index regarding the changes in milk yield and herd life were similar in fluctuation: bMY and bMS increased, whereas bAG , bUH , and bUS decreased.

Key Words: Economic weight, Selection index

1709 Determining Weights in a Multiple Objective Programming Dairy Breeding Problem. Peter Tozer* and Jeffrey Stokes, *The Pennsylvania State University.*

A survey of animal breeding scientists and representatives from breeding companies provided two sets of information regarding the rankings and relative importance of three objectives in the breeding decision: maximizing net merit; minimizing inbreeding; and minimizing semen cost. Each group ranked the objectives in a slightly different order; net merit was the top objective for both groups, while each group ranked the other two objectives in opposite order. The scores were analyzed through an application of the analytic hierarchy process to determine the set of weights from each group for use in multi-criteria decision making (MCDM) models. The models were used to examine the impact the different rankings and weights had on the sire portfolio selected. Another aspect of the MCDM model tested was the sensitivity of the results to the degree of non-linearity of the function chosen. Linear programming models of the three single objectives were estimated to provide the ideal and anti-ideal values for use in the MCDM models. The single objective models were based on selecting sires for a representative group of 60 cows to be bred. Constraints were placed on the total number of semen units to be purchased in total and on the number of units from any one sire. The portfolios of sires selected by the MCDM models for each set of weights are similar, in that sires with high net merit were selected. This is not surprising given that the net merit weights were approximately 4 times greater than the next objective for each group. Minor differences in the portfolio selected occurred when the model was changed from a linear formulation to the quadratic form. However, a major difference in the portfolios selected occurred when the degree of non-linearity increased from the quadratic to the MINIMAX formulation. In the MINIMAX portfolios the levels of the second objective, either inbreeding or semen cost, were reduced by 27% and 23% when compared to the linear specification portfolios, however, these reductions came at a reduction in average net merit of the portfolios, 9% and 12%, respectively.

Key Words: analytic hierarchy process, breeding, multiple objective programming

1710 Relationships and inbreeding among young dairy bulls entering AI progeny test programs. K. A. Weigel*, *University of Wisconsin, Madison.*

Inbreeding is an expected but undesirable consequence of rapid genetic progress in modern breeding programs. Reproductive technologies allow rapid propagation of a few elite individuals and families, and this can increase inbreeding levels quickly. In a two-stage selection scheme, inbreeding is primarily a function of relationships between young bulls entering artificial insemination (AI) progeny test programs. Our objective was to examine the genetic diversity present within the young AI sire populations of the five major US dairy breeds. Assuming an inbreeding base year of 1960, young sires born in 1998-1999 were, on average, related to their respective breeds by 13.1% for Ayrshires, 11.6% for Brown Swiss, 11.8% for Guernseys, 10.1% for Holsteins, and 14.6% for Jerseys. Individual sires of sons were extremely influential. The percentages of these young bulls that were sired by the five most popular sires of sons were 100% for Ayrshires, 68% for Brown Swiss, 71% for Guernseys, 42% for Holsteins, and 76% for Jerseys. Genetic diversity is also limited on the maternal side of the pedigree. Among the current elite cows (top 5%) in the US, the percentages of cows that were offspring of the five most popular sires were 45% for Ayrshires, 46% for Brown Swiss, 51% for Guernseys, 17% for Holsteins, and 57% for Jerseys. Dairy cattle breeding is a global business, and it appears that the major dairy countries are all drawing from the same gene pool. Data from countries that currently participate in the Interbull dairy sire evaluations were also examined. Individual sires of sons were used very heavily internationally. The percentages of bulls born in 1995 that were sired by the ten most popular sires of sons were 54% for Ayrshires, 59% for Brown Swiss, 100% for Guernseys, 43% for Holsteins, and 66% for Guernseys. Strategies such as computerized mating programs can help reduce inbreeding in the next generation of replacement heifers, but long term maintenance of genetic diversity will require constraining the relationships between young AI bulls.

Key Words: inbreeding, dairy sires, progeny testing

1711 The use of fuzzy set to reduce inbreeding in MOET breeding schemes. Atsushi Nakamura*¹, Kenji Togashi², Naoyuki Yamamoto², and Akiko Nishiura², ¹*Japan Science and Technology Corporation*, ²*Hokkaido National Agricultural Experiment Station.*

Increased rates of inbreeding in multiple ovulation and embryo transfer (MOET) breeding schemes may have an important effect on genetic response to selection and reproductive ability through inbreeding depression and loss of genetic variability. The assumption of constant family size per donor has been assumed in earlier studies of mate selection to control inbreeding. However, the number of mates per donor will vary because the family size changes, depending on the number of embryos per donor. Therefore, the objective of this study was to examine mate selection using fuzzy set to control inbreeding on the assumption of a variable family size. Mate selection was carried out based on a selective mating criterion (FMC), which is an aggregated value of two fuzzy sets by algebraic product and trade-off parameters. These fuzzy sets were described as 'higher average breeding value of mate pair' and 'lower coancestry', respectively. The fuzzy membership functions were defined as logistic function. The value of the trade-off parameter between these two fuzzy sets was set to from 0 to 1. Stochastic simulation was used to study the effect of mate selection on rates of genetic response and inbreeding with a closed adult MOET nucleus breeding program. Milk production the the selected trait and heritability was 0.30. The number of embryos collected from a donor in one flush was sampled from a Poisson distribution. Hierarchical and factorial mating designs were examined. When the trade-off parameter changed from 0.25 to 0.75, the genetic response and inbreeding rates in the hierarchical mating design ranged respectively from 100 to 98% and from 64 to 47% of those in a hierarchical random mating design. The responses in the factorial mating design ranged from 102 to 95% and 57 to 40%, respectively. In conclusion, mate selection based on FMC does not guarantee optimum mate decision as does mate selection with a mathematical programming method. However, this mate selection criterion avoided mating of close relatives and reduced inbreeding on assumption of a variable family size.

Key Words: Fuzzy set, Inbreeding, Mate selection

ASAS/ADSA Ruminant Nutrition: By-Products, Fiber, and Silages

1712 Effect of feeding dairy cows with either BollGard[®], BollGard[®] II, Roundup Ready[®] or control cottonseeds on feed intake, milk yield and milk composition. A.R. Castillo^{*1}, M.R. Gallardo¹, M. Maciel¹, J.M. Giordano¹, G.A. Conti¹, M.C. Gaggiotti¹, O. Quaino¹, C. Gianni², and G.F. Hartnell², ¹Experimental Station Rafaela INTA, Argentina, ²Monsanto Co., St. Louis, MO.

This experiment evaluated the effect of feeding dairy cows with cottonseeds containing BollGard[®] (Cry1Ac) and BollGard[®] II (Cry1Ac and Cry2Ab), Roundup Ready[®] (CP4 EPSPS) and control non-transgenic cottonseed on dry matter intake, milk yield and milk composition. Twelve lactating multiparous Argentinean Holstein cows weighing 570 kg (BW) were used in a 4x4 Latin square design, with 3 squares each containing 4 cows, four 4-week periods and four treatments. The treatments were control cottonseed non-genetically modified (DP50), BollGard[®] (DP50B) that contains the Cry1Ac gene, BollGard[®] II (DP50BII) that contain both Cry1Ac and Cry2Ab genes and Roundup Ready[®] (DP50RR) that contain the CP4 EPSPS gene. All the cows received the same diet of corn silage, alfalfa hay, ground corn, soybean meal, minerals, vitamins. The individual cottonseeds were hand mixed in with the diet. There were no significant differences ($P>0.05$) in total dry matter intake (DMI) or cottonseed intakes, averaging 23.7 and 2.3 kgDM/cow/d respectively. Milk yield, milk composition (fat, protein, lactose, non-fat solids and urea) and body condition score (BCS) were comparable ($P<0.05$) among the treatments. Results of this study indicate that cottonseed of genetically modified varieties (BollGard[®], BollGard[®] II and Roundup Ready[®]) shown similar performance as control cottonseed.

Parameter	DP50	DP50B	DP50BII	DP50RR	se	P<
DMI, kg/d	23.38	23.78	23.93	23.75	0.337	0.699
Cottonseed, kg/d	2.25	2.29	2.28	2.27	0.038	0.871
Milk yield, kg/d	26.87	26.71	27.56	27.42	0.622	0.724
Milk composition, %						
Fat	3.58	3.60	3.52	3.53	0.094	0.807
Protein	3.15	3.14	3.14	3.13	0.026	0.953
Lactose	4.97	5.01	5.04	5.00	0.024	0.166
Non-fat solids	8.84	8.91	8.96	8.90	0.043	0.341
Urea	0.040	0.042	0.044	0.043	0.0013	0.185
BCS	2.30	2.30	2.30	2.34	0.026	0.621

Key Words: Genetically modified cottonseeds, Milk production, Dry matter intake

1713 Effect of feeding dairy cows with cottonseeds containing Bollgard[®] and Roundup Ready[®] genes or control non-transgenic cottonseeds on feed intake, milk yield and milk composition. A.R. Castillo^{*1}, M.R. Gallardo¹, M. Maciel¹, J.M. Giordano¹, G.A. Conti¹, M.C. Gaggiotti¹, O. Quaino¹, C. Gianni², and G.F. Hartnell², ¹Experimental Station Rafaela, INTA, Argentina, ²Monsanto Co., St. Louis, MO.

The purpose of the experiment was to evaluate the effect of feeding dairy cows with cottonseed containing BollGard[®] (Cry1Ac) and Roundup Ready[®] (CP4 EPSPS) and control non-transgenic cottonseeds on feed intake, milk yield and milk composition. Twelve lactating multiparous Argentinean Holstein cows weighing 570 kg (BW) were used in a 4x4 Latin square design, with 3 squares each containing 4 cows, four 4-week periods and four treatments. The treatments were three non-transgenic cottonseeds from two commercial sources (Guazuncho and Pora), a parenteral line (Chaco520) and the genetically modified cottonseed (Chaco520BGRR). All the cows received the same diet of corn silage, alfalfa hay, ground corn, soybean meal, minerals and vitamins. The individual cottonseeds were hand mixed in with the diet. There were no significant differences ($P>0.05$) in total dry matter intake (DMI) or cottonseed intakes, averaging 22.9 and 2.3 kgDM/cow/d respectively. Milk yield, milk composition (fat, protein, lactose, non-fat solids and urea) and body condition score (BCS) were comparable ($P<0.05$) among the treatments. Results of this study indicate that cottonseed of genetically modified variety (BollGard[®] and Roundup Ready[®]) shown similar performance as control cottonseeds.

Parameter	Guazuncho	Pora	Chaco		sed	P<
			520	520BGRR		
DMI, kg/d	22.87	23.03	22.99	22.36	0.435	0.405
Cottonseed, kg/d	2.28	2.29	2.30	2.23	0.041	0.331
Milk yield, kg/d	26.79	27.42	27.47	26.48	0.878	0.637
Milk Composition, %						
Fat	3.36	3.26	3.32	3.35	0.099	0.775
Protein	3.15	3.09	3.32	3.35	0.052	0.550
Lactose	4.86	4.85	4.83	4.83	0.044	0.879
Non-fat solids	8.73	8.69	8.72	8.77	0.055	0.518
Urea	0.034	0.036	0.036	0.031	0.0022	0.117
BCS	2.31	2.36	2.33	2.25	0.056	0.265

Key Words: Genetically modified cottonseeds, Milk production, Dry matter intake

1714 Effect of chopped and ground roughage on ruminal parameters and voluntary feed intake of sheep. H. G. Gonzalez^{*1,3}, O. B. Ruiz², L. C. De la Vega², E. T. Rubio¹, O. R. Barrozo¹, N. E. Bujanda¹, N. A. Loya¹, E. S. Garcia¹, I. G. Ramos¹, and H. C. Hernandez⁴, ¹Medicina Veterinaria y Zootecnia-ICB, Universidad Autonoma de Ciudad Juarez, ²Universidad Autonoma de Chihuahua, ³Universidad Autonoma de Baja California, ⁴Universidad Autonoma de Baja California Sur.

Eight crossbred sheep (36 kg) with permanent rumen cannulas were used to evaluate if two different chop length: 2.5 cm (T1) and 10 cm (T2) of forage could affect ruminal parameters and voluntary feed intake. The animals were fed *ad libitum* with diets consisting of oat straw plus an alfalfa hay supplement (20 % of the diet). The supplement was offered once daily at 0800 h. Rumen fluid samples were collected of each animal at 0, 1.5, 3, 6, 9, 12, 16, and 24 h after meal and analyzed for pH, ammonia-nitrogen (NH₃-N) and volatile fatty acid (VFA) concentration. The analysis of data was using a crossover design. There were no differences ($P>.05$) in DMI (57.82 vs 58 g kg⁻¹W^{0.75}), pH (6.85 vs 6.93), NH₃-N(12.33 vs 12.27 mg 100ml⁻¹), propionic (14.87 vs 14.01 mM), butyric (5.64 vs 5.76 mM), and isobutyric (0.77 vs 0.77 mM) acids for T1 and T2, respectively. However, a significant difference was detected ($P<.08$) between T1 and T2 in concentration of acetic acid (78.22 vs 79.18 mM). The size of forage particle did not affect the DMI and ruminal parameters in sheep.

Key Words: Sheep, Ruminal parameters, Intake

1715 A comparison of methods used to measure eating and ruminating time in cattle. H. A. Lehman, P. J. Kononoff, and A. J. Heinrichs, *The Pennsylvania State University*.

Detailed knowledge of chewing and rumination activities are critical in order to fully understand the dietary factors affecting normal rumen function. An automatic system for the digital recording of the jaw movements in free-ranging grazing cattle has been described but its ability to measure chewing activity of cattle housed in confinement and fed total mixed rations has not yet been evaluated. The eating and ruminating behaviors of eight lactating dairy cows were recorded simultaneously by a wireless automatic system and by observation over 24 h periods. Data recorded by the automatic system were processed to identify periods of eating and ruminating in each of the cows. Mean total time eating and ruminating as measured by each method were compared using a paired sample t test. Results indicated both methods agreed on identification of eating and ruminating activities 99.1 % and 97.7%, respectively. Mean differences between methods for total time eating (31.0 min + 23.14) and ruminating (54.8 min + 19.13) were significantly different. The time recorded by observation in both eating and rumination was approximately 15% higher when compared to the automatic system. Disagreement between methods most likely indicates inaccuracies in the observational method itself. When different methods of measurements are used to approximate biological parameters such as salivary buffer flow or the amount of energy expended on chewing activity, overestimation was consistent when the observational method was employed. The

automatic system may prove useful in further studies examining eating and rumination activities in cattle.

Key Words: ruminating behavior, eating behavior, Graze software

1716 Effect of two particle sizes of forage on ruminal parameters and voluntary feed intake of steers fed a basal oat straw diet. H. G. Gonzalez^{1,3}, O. B. Ruiz², L. C. De la Vega², E. T. Rubio¹, O. R. Barrozo¹, N. E. Bujanda¹, N. A. Loya¹, I. G. Ramos¹, E. S. Garcia¹, and H. C. Hernandez⁴, ¹Medicina Veterinaria y Zootecnia-ICB, Universidad Autonoma de Ciudad Juarez, Mexico, ²Universidad Autonoma de Chihuahua, ³Universidad Autonoma de Baja California, ⁴Universidad Autonoma de Baja California Sur.

Four Hereford steers (300 kg) with permanent rumen cannulas were used to evaluate two chop lengths: 2.5 cm (T1) and 10 cm (T2) of forage on ruminal parameters and voluntary feed intake. The animals were fed *ad libitum* with a basal oat straw diet plus an alfalfa hay supplement (20 % of the diet). Alfalfa was offered once daily at 0800 h. Rumen fluid samples were collected from each animal at 0, 1.5, 3, 6, 9, 12, 16, and 24 h after meal and analyzed for pH, ammonia-nitrogen (NH₃-N) and volatile fatty acids (VFA) concentration. The analysis of data used a switch back design. A higher DMI was observed ($P < .09$) in T1 compared to T2 (78.64 vs 72.07 g kg⁻¹W^{.75}). No differences ($P > .05$) were found in pH (7.82 vs 7.56), NH₃-N (6.81 vs 6.91 mg 100ml⁻¹), and propionic acid (15.36 vs 14.98 mM) for T1 and T2, respectively. However there were significant differences ($P < .01$) between T1 and T2 in concentration of butyric (6.51 vs 4.89 mM), isobutyric (0.74 vs 0.4 mM), and acetic ($P < .07$; 77.39 vs 79.72 mM). The size of forage particle affected the VFA concentration and DMI.

Key Words: Steers, Ruminal parameters, Intake

1717 Feed Intake, Digestibility, and Growth of Spanish Goats Consuming Different Quality Diets. T. Wuliji, A.L. Goetsch, R. Puchala, S. Soto-Navarro*, R.C. Merkel, G. Detweiler, T.A. Gipson, and T. Sahlu, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.*

Fifty-two Spanish kids (average initial BW = 13.5 ± 0.06 kg) were used in an experiment with two 9-wk phases. Three diets were used: prairie hay consumed *ad libitum* and supplemented with 0.125% BW (DM) of soybean meal (average = 21.4 g/d; H), dehydrated alfalfa pellets consumed *ad libitum* (A); and a 70% concentrate diet consumed *ad libitum* (C). Treatments were A in Phases 1 and 2 (AA), C in Phases 1 and 2 (CC), H in Phase 1 and A in Phase 2 (HA), H in Phase 1 and C in Phase 2 (HC), and A in Phase 1 and C in Phase 2 (AC). Dry matter intake in Phase 1 was lowest ($P < 0.05$) for HA and HC and greater ($P < 0.05$) for AA and AC than for CC (636, 502, 385, 352 and 634 g/d), and DMI in Phase 2 was 839, 629, 834, 636 and 805 g/d (SE = 12.6) for AA, CC, HA, HC, and AC, respectively. Average daily gain for AA, CC, HA, HC, and AC, respectively, was 81, 79, 0, 0 and 86 g (SE = 17.6) in Phase 1 and 73, 54, 112, 82, and 92 g (SE = 29.9) in Phase 2. Apparent total tract DM digestibility, determined at the end of the performance period with five animals per diet, ranked ($P < 0.05$) H < A < C (39, 54, and 66%, respectively). Likewise, ruminal pH was greatest for C and lowest for H ($P < 0.05$; 6.0, 6.5, and 6.8 for H, A, and C, respectively). The concentration of total VFA in ruminal fluid at 4 h after feeding was 35, 104, and 68 mmol/L for H, A, and C, respectively (SE = 3). In conclusion, dehydrated alfalfa pellets supported performance of Spanish kids as great or greater than that with a concentrate-based diet, when fed continuously and following consumption of a low-quality forage-based diet.

Key Words: Goats, Growth, Diet Quality

1718 Methane loss, nutrient digestibility, and net energy value of distiller's grains fed to steers or fermented *in vitro*. M. J. Jarosz*¹ and D. E. Johnson², ¹Purina Mills, St. Louis, MO, ²Colorado State University.

The nutrient digestibility, methane production, and net energy value of dried distiller's grains (DG) was measured with steers by concomitant 2-d respiration calorimetry and 7-d balance trial. Effects of the concentration of DG, dried brewer's grains (BG) or oil on methane production were determined by *in vitro* gas pressure technique. Six steers were fed

a 60% concentrate basal diet with 0, 20, or 40% DG and energy partitioning measured in a 3 x 3 Latin square design. Four *in vitro* trials evaluated 0, 20, 40, 60, 80, and 100% BG or DG replacing alfalfa, 0, 2, 4, 6, 8, and 10% corn oil replacing corn gluten feed (CGF), and normal and non-lipid BG and DG. Inclusion of DG in the diet fed to steers did not significantly decrease methane production (5.9%, versus 6.2% of GE for control diet). Successive DG additions to the alfalfa substrate, *in vitro*, first increased and then decreased methane production to 19% below control when 100% DG was fermented (cubic effect, $P < 0.01$). Methane production was also first increased and then decreased (quadratic, $P < 0.01$) when BG was successively added *in vitro*, reducing methane to 62% of control at 100% BG. *In vitro* additions of corn oil to corn gluten feed linearly ($P < 0.01$) decreased methane production over concentrations ranging from 0 to 10%, while removal of lipid from BG or DG did not alter methane production. When fed to steers, the distiller's grains additions of 20 and 40% did not significantly change DM digestibility, however, NDF digestibility increased ($P < 0.05$) by 17 and 30%, and %DE increased by 2 (N.S.) and 8% when compared to the control diet. Similarly, ME (Mcal/kg DM) content of the DG diets was 7% greater ($P < 0.05$) for each 20 percentage unit addition of DG to the diet. The heat production by the steers did not change with diet resulting in slightly greater (N.S.) partial efficiencies of ME use for maintenance and gain and a 10 and 19% improvement in NEm and NEg content of the 20 and 40% DG diets above control. Calculated by difference using the respiration calorimetry technique, the energy value of DG is; ME, 3.88, NEm, 2.92, and NEg, 2.42 Mcal/kg DM. Applying the slaughter balance derived conversion from ME to NE (NRC, 1996) provides estimates of 2.73 Mcal NEm and 1.95 Mcal NEg/kg DM, 25 to 30% above current tabular values.

Key Words: Distiller's grains, Methane, Net energy

1719 The effect of feeding a novel silage, consisting of liquid cheese whey and wheat straw, on production and digestibility characteristics of growing dairy heifers and beef steers. D.R. ZoBell*, K.C. Olson, R.D. Wiedmeier, and C.A. Stonecipher, *Utah State University, Logan, UT.*

A novel whey silage (WS) was produced in bunker silos at two separate locations. Liquid cheese whey (50% DM) was combined with wheat straw and wheat middlings at proportions of 63.1%, 28.9% and 8.0% (DMB) respectively. Nutrient and fermentation analysis of the WS (30d ensiling period) indicated approx. 44.8% DM, 14.3% CP, 1.87 Mcal/kg NEm, 1.23 Mcal/kg NEg, 4.3 pH, 10.5% lactic acid and 11.2% Total VFA (DMB). At location 1, 60 weaned beef steers were assigned either Control (C), Treatment 1 (T1) or Treatment 2 (T2). There were 5 steers per pen and 4 pens per treatment for this 56d trial. The C steers received 19.0% alfalfa hay (AH), 32.4% corn silage (CS), 39.9% rolled barley (RB), 5.6% SBM and 3.1% supplement and T1 and T2 steers 24.8% CS, 31.0% WS, 35.7% RB, 5.2% SBM and 3.3% supp or 65.5% WS, 31.3% RB and 3.2% supp respectively. All rations were isocaloric and isonitrogenous. Overall ADG (kg), DMI (kg) and FE for C, T1 and T2 steers were 1.18, 1.25, and 1.34 ($P = .09$); 7.09, 8.68 and 9.36 ($P = .0001$); 6.04, 7.01 and 7.07 ($P = .02$) respectively. *In vivo* DM and NDF digestibilities were similar when comparing C and T2 diets ($P > .05$). At location 2, 48 growing holstein heifers were assigned C or T diets with 8 heifers per pen and 3 pens per treatment for 56d. Control heifers received 16.8% AH, 46.2% CS, 36.9% wheat middlings and .1% supp. and T heifers 98.3% WS and 1.7% supp. The C and T rations were isocaloric and isonitrogenous. Overall ADG (kg), DMI (kg) and FE for C and T heifers were 1.14 and 1.07 ($P = .05$), 7.47 and 5.91 ($P = .001$) and 6.55 and 5.57 ($P = .028$) respectively. *In vitro* DM digestibility was improved with treatment ($P < .05$). Whey silage can be produced successfully and can increase production characteristics of growing holstein heifers but may not in growing beef steers.

Key Words: cheese whey, silage, growing steers and holstein heifers

1720 Selected fractionate digestibility coefficients of wheat middling and soybean hull mixtures amended with human food waste. P.M. Walker*, J.M. Dust, D.M. Finnigan, and S.B. Brown, *Illinois State University, Normal, IL USA.*

Suffolk wethers 6 - 7 months old and weighing 44.6 ± 4.8kg were used in two trials (T1 and T2) to determine the apparent digestible energy and digestibility coefficients of dietary DM, CP, ADF and ether extract (EE) of a dehydrated wheat middling (WM) and food waste mixture (DF) and

an extruded soybean hull (SBH) and food waste mixture (EF). In T1 WM and ground food waste originating from retail groceries were mixed in a 75: 25 ratio (DM basis), passed through a grinder/pelletizer and dehydrated. In T2 pulped plate waste (PW) obtained from university dining centers was mixed and extruded in a 40: 60 ratio (wet wt. basis) with an extruded combination of PW: SBH: rolled corn (40: 55: 5), on a wet wt. basis to provide a mixture containing 40.4% PW on a DM basis. In T1 and T2 28 lambs were randomly allotted to metabolism crates and were fed the extruded feed mixtures at 3.6% and 3.8% of body wt, respectively, for 30d with total fecal collection the last 7d. Gross energy was determined on all samples with an adiabatic bomb calorimeter. DF was found to contain 92.7 ± .4% DM, 20.9 ± 3.0% CP, 7.9 ± .6 ether extract (EE) and 11.2 ± .7% ADF. Apparent digestible energy of DF was determined to be 3.17 ± .24 Mcal/kg. DF apparent digestibility coefficients were 65.0 ± 4.8% DM, 75.0 ± 4.9% protein, 15.7 ± 10.8% ADF and 79.4 ± 5.1 EE. EF was found to contain 93.9 ± .9% DM, 17.7 ± 4.4% CP, 4.8 ± .7% EE and 32.2 ± 2.3% ADF. Apparent digestible energy of EF was determined to be 2.66 ± .18 Mcal/kg. EF apparent digestibility coefficients were 58.2 ± 4.2% DM, 62.5 ± 7.3% CP, 27.2 ± 7.8% ADF and 79.8 ± 6.7% EE. This study suggests amending WM and SBH with food waste is an acceptable method for including human food waste in livestock diets.

Key Words: Food Waste, Digestibility Coefficients

1721 Effects of feeding wheat middlings on performance of dairy cows in early lactation. G.D. Marx*, *University of Minnesota, Crookston, MN.*

Forty early lactation primiparous and multiparous Holstein cows were equally assigned to either a diet containing 10% wheat middlings (WM) or a control diet containing corn and soybean meal (CS) at equal ration DM content. The objective of the study was to determine the value of wheat middlings, an economic opportunity feed, using high producing cows. Performance of cows was determined on the two diets during a 12-wk study preceded by a 2-wk standardizing period. Total mixed rations were fed once daily to each group with the balance of the ration consisting of alfalfa haylage, corn silage, high-moisture corn, soybean meal, vitamins and minerals to meet NRC requirements for high producing cows. Cows were kept in individual tie stalls and fed to appetite plus 2.3 kg adjusted daily according to intake. Daily DMI and weigh-backs were measured on each individual cow. General linear models of SAS were utilized to determine statistical significance of the data. Daily milk production, milk fat and milk protein for cows fed WM were 36.9, 1.31 and 1.17 kg and cows fed CS were 38.0, 1.23 and 1.19 kg. Milk production and these milk components did not differ ($P>0.05$) between groups. Peak milk production was similar on each treatment. Average daily DMI did not differ between treatments and were 21.92 and 21.67 kg for the WM and CS fed cows. Average body condition scores were similar for both the WM and CS groups with scores of 3.18 and 3.12. Average daily BW gains of cows during the experimental period for the WM and CS were 0.32 and 0.21 kg. The SCC of milk with the WM treatment was slightly higher than the CS treatment group. Reproduction data indicated no difference in number of services and subsequent conception between treatments. No unusual health conditions or nutritional disorders occurred with any of the cows. Results of this feeding trial indicate that the wheat middlings byproduct feed was an acceptable and economical component at 10% of the ration DM for early lactation dairy cows.

Key Words: Wheat middlings, Early lactation, Dairy cow

1722 The prediction of potential nutrient supply to dairy cows from field pea (*Pisum sativum*) seeds pressure-toasted at various conditions. P. Yu*¹ and J.O. Goelema², ¹*Department of Animal and Poultry Science, University of Saskatchewan, Canada,* ²*Department of Animal Nutrition, Wageningen Agricultural University, The Netherlands.*

Field pea seeds (*Pisum sativum*, also called marrowfat pea, small blue pea, dry pea, arveja or muttar) have particularly high starch and protein contents (around 45% and 25%, respectively). However their rapid and extensive degradation of protein and starch by rumen microbes make them unsuitable and/or inefficient to be used in the unprocessed form in diets for high producing dairy cows. It is advantageous to have more starch and protein escape degradation in the rumen to provide a source of glucose and amino acid in the small intestine to achieve a higher milk

production. In this study, a systematic research was carried out on the effects of pressure toasting of field pea seeds at various conditions (100, 118 and 136C for 3, 7, 15 and 30 min) on rumen degradability and intestinal digestibility of protein and starch, as measured by in sacco nylon bag and mobile bag techniques in lactation dairy cows and on potential nutrient supply to dairy cows, as predicted by the DVE/OEB model. The results show that with increasing temperatures and times, pressure toasting increased ($P<0.01$) rumen bypass protein (BCP) from 58 to 149 g/kg DM and starch (BSt) from 158 to 248 g/kg DM without negatively affecting intestinal digestibilities, increased ($P<0.01$) intestinally absorbed rumen bypass protein (ABCP) from 54 to 145 g/kg DM and starch (ABSt) from 81 to 190 g/kg DM, increased ($P<0.01$) intestinally absorbable protein (DVE) from 115 to 189 g/kg DM and decreased ($P<0.01$) the degraded protein balance (OEB) from 88 to 25 g/kg DM. The highest increases of BCP, BSt, ABCP, ABSt and DVE were 156, 57, 169, 189 and 64%, respectively and the highest decrease of OEB was 72%, at 136C/15 min, over the raw seeds. The results indicate that the effects of pressure toasting on potential nutrient supply of field pea seeds to dairy cows were very much dependent on the conditions applied during processing. It was concluded that pressure toasting could be used as an effective treatment to increase potential nutrient supply to dairy cows by decreasing the OEB value and increasing the BCP, BSt, ABCP, ABSt and DVE values. The largest response was found after toasting for 15 min at 136C.

Key Words: Pressure toasted peas, DVE/OEB model, Cow

1723 Ruminal degradability of feather meal in tropical crossbred steers. J. Vergara-Lopez*¹, O. Araujo-Febres², Y. Troconis², and M. Lachmann³, ¹*Instituto Nacional de Investigaciones Agrícolas,* ²*Departamento de Zootecnia, Facultad de Agronomía, La Universidad del Zulia,* ³*Departamento de Producción Animal, Facultad de Ciencias Veterinarias, La Universidad del Zulia.*

An evaluation of ruminal degradability of feather meal (FM) was made using two crossbred tropical steers fitted with permanent rumen cannulae. Samples of FM (93.37 and 90.30% DM and OM), corn meal (CM; 92.12 and 87.88% DM and OM) and *Brachiaria humidicola* hay (HH, 92.86 and 87.63% DM and OM) were incubated in the rumen for 0, 1, 2, 4, 6, 12, 24, 36, 48, 60 and 72 h. Dry matter and OM degradabilities were calculated. Dry matter degradability of FM at 72h was 43.0 ± 0.86%, lower than ($P<0.01$) CM and HH (90.70 ± 3.11% and 63.37 ± 0.64, respectively). Organic matter degradability was similar (42.77 ± 0.86, 90.38 ± 3.28% and 62.22 ± 0.75% for FM, CM and HH respectively). Dry matter degradation rate of FM was 0.0115 ± 0.0022, lower than ($P<0.05$) CM 0.0261 ± 0.0048 and HH 0.035 ± 0.012. Organic matter degradation rate was similar (0.0124 ± 0.003, 0.0320 ± 0.009 and 0.0349 ± 0.0117 for HP, HM and HH respectively). Ruminal degradability of FM was lower than of CM and HH. These results suggest that FM may be an important by-product.

Key Words: Feather meal, Ruminal degradability, Tropics

1724 Effect of cull chickpeas variety on apparent digestibility of diets for sheep. G. Quevedo², J. F. Obregon*¹, R. Barajas¹, and A. Estrada¹, ¹*Universidad Autonoma de Sinaloa (Mexico),* ²*DGETA-SEP- Sinaloa (Mexico).*

To determine the effect of chickpeas variety on the apparent digestibility of diets for sheep, 4 lambs (Pelibuey, males, BW = 22.2 kg) were used in a Latin square design experiment. The treatments were: 1) 60% sorghum grain (control) 20:80 roughage:concentrate (13.7% CP and 3.41 Mcal of DE/kg of DM); 2) 30% sorghum and 30% chickpeas variety "Blanco Sinaloa"; 3) 30% chickpeas variety "Tubutama" and 30% sorghum; and 4) 30% chickpeas variety "Porquero" and 30% sorghum. The animals were housed in metabolic crates (1.2 x 0.6 m) and were fed twice a day (3.2% of BW). After 10 d of diet adaptation, samples of food and total feces production were collected for 4 d. Samples were oven dried (110°C 24 h), ashed and CP (N x 6.25; Kjeldhal) analyses were performed. Chickpeas variety had no effect ($P>0.10$) on dry matter digestibility (mean value = 79.5%). Organic matter digestibility was not affected ($P>0.10$) by treatments (mean value = 81.1%). CP digestibility of Porquero variety diet was 3% lower ($P<0.05$) than the other chickpeas varieties (77.48 vs. 79.81%). CP of sorghum diet was 7% less digestible ($P<0.01$) than chickpeas diets (73.33 vs. 79.03%). The DE of diets was not different ($P>0.10$) among treatments (mean value = 3.41 Mcal/kg). Observed/expected DE, was 3% lower ($P<0.05$) in chickpeas diets than

sorghum diet (0.97 vs 1.0) True digestibility of chickpeas crude protein was calculated to be 96% for Blanco Sinaloa and Tubutama varieties, while that for Porquero was estimated to be 89%. The DE content of cull chickpeas was estimated to be similar to sorghum grain (3.79 Mcal/kg). It is concluded that cull chickpeas varieties possess different value as a crude protein source for sheep, but their energy content is not impacted by variety.

Key Words: Chickpeas, Digestibility, Sheep

1725 Effect of feeding dairy cows with whey permeate on ruminal environment under alfalfa grazing conditions. M.C. Gaggiotti¹, M.R. Gallardo¹, A.A. Abdala¹, C. Arakaki², L. Burdisso¹, and A.R. Castillo*¹, ¹INTA-EEA Rafaela, ²INTA-CICV.

Whey permeate is an energetic byproduct resulting from the protein extraction of cheese whey (18% DM and 15% lactose) with a potential use in dairy cattle feeding. The objective was to determine the effects of whey permeate on the rumen environment of dairy cows grazing alfalfa. Six ruminally fistulated dairy cows (541 kg BW; 175 DIM; 15 kg of milk/cow/day) were used in a complete change-over design (2 treatments and two 4 wk periods). The treatments were a control diet (Tc) based on alfalfa pastures (strip-grazing) and 3.5 kg DM/cow/day of ground corn grain; and the whey permeate diet (Tp) where corn grain was replaced by 20 l/cow/day of whey permeate (3.6 kg DM/cow/day). Ground corn grain and whey permeate were supplied twice daily through the rumen cannula at the same time in both treatments (7 and 15 h). Ruminal fluid samples were collected at 6, 9, 12, 15, 18, 21 h and analyzed for pH, NH₃, VFA concentration and total count of amylolytic and cellulolytic bacteria. There were significant differences ($P < 0.05$) in NH₃ (Tc: 16.98 vs Tp: 11.26 mg%), pH (Tc: 6.55 vs Tp: 6.40), acetic acid (Tc: 68.6 vs Tp: 63.8 mM) and butyric acid (Tc: 11.4 vs Tp: 6.52 NMP $\times 10^9$ /ml). Although the whey permeate produced a different ruminal environment when it was compared with ground corn grain, this byproduct may be used as an energy source for dairy cows grazing alfalfa pasture.

Key Words: Whey permeate, Grazing dairy cows, Rumen environment

1726 Nutritional value of nonforage fiber sources used by feed industry in Costa Rica. M. Cruz¹, J. Ml. Sanchez*¹, and E. Vargas, ¹Universidad de Costa Rica, San Jose, Costa Rica.

A total of 40 samples of common nonforage fiber sources used in dairy cattle feeding in Costa Rica was taken to estimate their nutritional value. Crude protein, NDF, ADF, lignin, silica, ether extract and ash contents were analyzed. Protein was fractionated and energy content was estimated. Results of soybean hulls had 15.5, 20.3, 32.2, 23.6 and 8.4% of the A, B1, B2, B3 and C protein fractions, respectively. Likewise, palm kernel meal (solvent extracted) had 3.7, 5.8, 8.2, 66.2 and 16.1% of the fractions mentioned before. Rice hulls and corn cobs had low concentrations of CP and high proportions of C fraction, with 53.8 and 56.1%, respectively. Corn bran had the highest hemicellulose content (62.7%) and the lowest levels of lignin (1.1%) and silica (0.04%). Soybean hulls had similar characteristics, however its hemicellulose content was lower than in corn bran and cellulose was higher. Soybean hulls and corn bran had higher ($P < 0.05$) estimated energy values than the other products. In general, soybean hulls had the highest nutritional value because of its protein content and quality, and its energy content.

Byproduct ¹	CP	NDF	ADF	Lignin	NFC ²	NE _i		
						(3x)	NE _m	NE _g
% of DM						Mcal/kg of DM		
Soybean								
hulls	14.0 ^b	62.7 ^d	47.0 ^d	2.6 ^c	20.3 ^a	1.43 ^a	1.55 ^a	0.95 ^a
Rice hulls	2.6 ^d	75.7 ^c	74.0 ^a	17.3 ^a	5.9 ^b	0.26 ^d	0.08 ^d	0.00 ^c
Palm kernel meal								
meal	16.3 ^a	84.5 ^b	57.3 ^b	15.6 ^b	4.5 ^{b,c}	0.90 ^b	0.93 ^b	0.38 ^b
Corn cobs	2.5 ^d	94.1 ^a	50.8 ^c	11.0 ^b	3.2 ^c	0.72 ^c	0.71 ^c	0.17 ^b
Corn bran ³	5.2 ^c	74.2 ^c	19.4 ^c	1.1 ^e	20.0 ^a	1.39 ^a	1.5 ^{1a}	0.91 ^a

(a,b,c,d,e) Means in a column with different superscripts are different ($P \leq 0.05$) ¹Average of eight samples ²Calculated by difference (NFC=100-NDF-CP-ash-ether extract) ³Byproducts from tortilla industry

Key Words: Nutritional value, Nonforage, Fiber sources

1727 Performance and apparent digestibility of ram lambs fed safflower silage. F.T. Sleiman*¹, O.D. Sayour¹, S.K. Yau¹, M.T. Farran¹, and M.G. Uwayjan¹, ¹American University of Beirut, Beirut, Lebanon.

Nine Awassi ram lambs averaging 43 kg BW were used in a 4-wk digestibility study with 1-wk collection period to determine the effect of feeding safflower silage (SFS) as the sole roughage or in a 1:1 ratio with barley silage (BS) on apparent digestibility and BW change of Awassi ram lambs. The experimental silage treatments were: 1) 100% SFS, 2) 100% BS, and 3) 1SFS: 1BS, mixed at feeding time. In addition to ad libitum silage feeding, each lamb consumed 0.7 kg DM/d concentrate (16.5% CP, on DM basis). All lambs gained weight by the end of the study with the 100% SFS fed lambs having the highest gain (156 g/d). BW change, however, was not significantly different ($P > 0.05$) among treatments. Furthermore, silage DMI was not significantly different ($P > 0.05$) and averaged 1.0 kg DM/d. Apparent digestibilities of DM (79.3, 75.3 and 77.8%) and EE (74.9, 89.2 and 79.8%) were not significantly different ($P > 0.05$) among the 100% SFS, 100% BS and the 1SFS: 1BS fed lambs, respectively. Lambs that received the 100% SFS manifested a significantly higher CP digestibility ($P < 0.05$) than those fed the 100% BS (77.8 vs. 67.9%); whereas CF digestibility was not different ($P > 0.05$) between these two silage groups (83.5 vs. 82.8%). This study indicates that SFS, when adequately prepared, is well accepted and efficiently digested by young ram lambs.

Key Words: Safflower silage, Digestibility, Performance of ram lambs

1728 Potential of apple pulp as silage for ram lambs. F.T. Sleiman*¹, R.A. Sarkis¹, M.G. Uwayjan¹, and M.T. Farran¹, ¹American University of Beirut, Beirut, Lebanon.

Silage characteristics, acceptability and apparent digestibility of ensiled apple pulp were studied using 12 Awassi ram lambs averaging 52 kg BW. The study consisted of a 4-wk trial with 1-wk collection period. The experimental treatments were: I) 100% apple pulp silage (APS), II) 100% barley-vetch silage (BVS), III) 70% APS + 30% ground yellow corn (GYC) and IV) 60% APS + 40% GYC. In addition to ad libitum silage feeding, each ram lamb was offered 1 kg concentrate (14% CP on DM basis). Changes in temperature of treatments containing the APS (I, II and IV) were not significantly different ($P > 0.05$) and averaged for the first 7d after ensiling 18.3, 18.4 and 19.2C, respectively. pH of treatment I was significantly lower ($P < 0.05$) than those of treatments III and IV by 7d after ensiling (3.3 vs. 3.5 and 3.8, respectively) and remained so until 16 d (3.4 vs. 3.5 and 3.9, respectively). Silage DMI was not different among treatments ($P > 0.05$) and averaged 0.4, 0.3, 0.4 and 0.6 kg/d, respectively. All lambs gained weight by the end of study with lambs on treatments I and IV having the highest gains (126 g/d), although changes in BW were not different ($P > 0.05$). Treatments apparent digestibilities of DM (72.3, 69.6, 73.9, and 74.9%), CP (62.9, 62.1, 59.5 and 62.8%) and CF (48.6, 47.3, 40.6 and 38.6%) were not different ($P > 0.05$). The EE digestibility of BVS (II) was significantly higher ($P < 0.05$) than those of treatments I and III (68.5 vs. 42.8 and 47.4%, respectively) but not different ($P > 0.05$) from that of treatment IV (67.1%). Results of this study indicate that apple pulp silage is acceptable and efficiently digested by ram lambs when properly prepared.

Key Words: Apple pulp silage, Apparent digestibility, Ram lambs

1729 Effect of substitution of common beans hay with Sudan grass hay on apparent digestibility of diets for sheep. R. Barajas*¹, J.F. Obregon¹, G. Quevedo², and A. Estrada¹, ¹Universidad Autonoma de Sinaloa, ²DGETA-SEP-Sinaloa.

To determine the effect of substitution of common beans hay (CBH) with Sudan grass hay (SGH) on apparent digestibility of diets for sheep, a digestion experiment was conducted. Four sheep (Pelibuey, males, BW=20.47 kg) were used in a crossover design. The treatments were: 1) Sudan grass hay 40% (11.24% CP and 2.96 Mcal DE/kg), canola meal 14%, sorghum grain 33.6%, sugar cane molasses 10%, urea 0.6%, and mineral premix 1.8%; and 2) A diet similar to control 40% of CBH instead of SGH. The animals were housed in metabolism crates (1.2 x 0.6 m) and were fed twice a day (3.1% of BW). After a 10 d adaptation period to the diet, samples of food and total fecal production were collected for 4 d. Samples were oven dried (110°C, 24 h), ashed and CP (N x 6.25; Kjeldhal) analyses were performed. Dry matter intake was

similar ($P > 0.10$) between treatments. Organic matter intake was higher ($P < 0.05$) in SGH. Intake of CP was higher ($P < 0.01$) in CBH (70.9 vs. 112 g/d). Fecal DM and OM were higher ($P < 0.01$) in SGH than in CBH. Fecal excretion of CP was not affected by treatments ($P > 0.10$). Common beans hay increased ($P < 0.01$) in 6% DM digestibility (69.9 vs. 73.4%). Digestibility of OM was improved ($P < 0.01$) in 9% by CBH. Apparent digestibility of CP was increased ($P < 0.01$) by 16% with the inclusion of CBH (69.1 vs. 80.1%). Observed/expected CP digestibility was not affected ($P > 0.10$) by type of hay supplied (1.12 vs. 1.09). Diet DE was increased ($P < 0.01$) by 10.6% with substitution of SGH for CBH (2.92 vs. 3.23 Mcal/kg). Observed/expected DE content of diets was higher ($P < 0.01$) for CBH than SGH (0.99 vs. 1.09). The DE content of CBH was calculated to be 3.2 Mcal/kg. It is concluded, that common beans hay can be used as ingredient in sheep feeding and that its DE content is approximately 3.2 Mcal/kg.

Key Words: Common beans, Digestibility, Sheep

1730 Ruminal degradation of crude protein of cull chickpeas using nylon bag technique in sheep. J.F. Obregon*¹ and R. Barajas¹, ¹Universidad Autonoma de Sinaloa.

The nylon bag technique was used to determine the ruminal degradation of crude protein of cull chickpeas in sheep. Three sheep (Pelibuey; males, BW=34 kg) were fitted with T cannulas in rumen. The animals were fed a diet containing sudan grass hay 18%, sorghum grain 30%, cull chickpeas 30%, canola meal 10.2%, sugar cane molasses 9%, urea 0.6%, and mineral premix 2.2% (17% CP and 3.34 Mcal DE/kg). Pairs of nylon bags (12 x 18 cm) containing five grams of ground chickpeas (CHP) or soybean meal (SBM) were placed in rumen, and incubated for 2, 4, 6, 8, 12, 16, 20, and 24 h. After removal from the rumen, residual CP content were determined. Solubility was obtained placing the bags in a 0.15 N NaCl solution. Kinetic parameters A, B, and C were calculated for CHP and SBM. Rate of passage of small protein particles (K) was estimated as 0.02 to calculate the effective degradability of CP in rumen. Residual CP values of CHP at 0, 12 and 24 incubation were used to obtain the rumen undegradable crude protein (UCP), taking as reference the value of 20% for SBM. Chickpeas CP was 79% more soluble ($P < 0.01$) than SBM-CP (26.3 vs. 14.6%). The CP disappearance from nylon bags was higher ($P < 0.05$) for CHP than SBM during the first 20 hours of incubation. CP degradability at 24 hours was similar ($P > 0.10$) for CHP and SBM (95.9 vs. 91.8%). The degradation rate of CHP-CP was 0.073 %/h ($R^2 = 0.96$). The effective CP degradation in rumen for CHP was estimated to be 93.7%. The calculated rumen UCP content of chickpeas was 6.5%. It is concluded, that CP of chickpeas is extensively degraded in rumen of sheep, and that its UCP content is close to 6.4%.

Key Words: Chickpeas, Crude protein, Sheep

1731 Ruminal fermentation, digestion kinetics, and nutrient flow in steers fed diets containing poultry manure and urea or blood meal as the main source of nitrogen. J. Mejia-Haro¹, O. Ruiz-Barrera², I. Mejia-Haro³, and J.A. Jimenez-Castro², ¹Universidad de Guanajuato, Mexico, ²Universidad Autonoma de Chihuahua, Mexico, ³CIGA-ITA de Aguascalientes, Mexico.

A study was carried out to evaluate the effects of two sources of nitrogen (poultry manure-urea, and blood meal) and levels of blood meal in diet on ruminal fermentation, digestion kinetics, and nutrient flow of beef steers. Four steers with ruminal and duodenal cannula were assigned to a Latin square design 4 X 4. The treatments were: T0, a control diet with RDP using a poultry manure-urea supplement; T150, a diet with a low level of RUDP, using blood meal (150 g/d); T300, a diet with an intermediate level RUDP (300 g/d); and T450, a diet with a high level of RUDP (450 g/d). The steers were fed twice a day. Before feeding, a chromic oxide bolus (6 g) was placed into the rumen. The experimental period lasted 12 d and the last 5 d, samples of feed, feces, and ruminal and duodenal contents were collected. Data were analyzed by ANOVA using the GLM of SAS (1993). No differences ($P > .05$) were found on the ruminal pH among treatments. T0 presented the highest concentration of ammonia nitrogen ($P < .05$). The total concentration of VFA and the molar proportion of butyric acid were not affected ($P > .05$). However, the molar proportion of acetic and propionic acids were affected ($P < .05$). In the kinetics of the liquid fraction, differences were not observed ($P > .05$) for dilution rate, ruminal volume, turnover time, fluid flow rate, and turnover per day. Similarly, in the kinetics of the

solid fraction, differences were not observed ($P > .05$) for low constant rate, fast constant rate, passage rate, mean retention time, mean retention time in the first compartment, mean retention time in the second compartment and total mean retention time. The duodenal flow of OM, total nitrogen, microbial N, NH₃-N, non-ammonia N and diet N was not affected ($P > .05$) by treatments. Similarly, no differences ($P > .05$) among treatments were found in the ruminal digestibility of OM, microbial and N efficiency. Total apparent digestibility of DM, OM, and N was not different among treatments ($P > .05$). However, the total apparent digestibility of ADF and NDF was affected by treatments ($P < .05$). The lowest value was observed in T0. In general, all the treatments presented a similar pattern in ruminal fermentation, liquid and solid kinetics and the outflow of nutrients to the duodenum.

Key Words: Fermentation, Rumen, Protein

1732 Comparison of nutrient digestibility between Roundup Ready® beets and pulp derived from Roundup Ready® beets and conventional beets and pulps. T. Hvelplund* and M.R. Weisbjerg, Danish Institute of Agricultural Sciences, Denmark.

Roundup Ready® (RR) sugar and fodder beets have been developed, which can tolerate Roundup® (glyphosate) herbicide treatment due to production of the 5-enolpyruvylshikimate-3-phosphate synthase protein (CP4 EPSPS) from *Agrobacterium sp.* strain CP4. The purpose of these experiments was to examine whether RR sugar and fodder beets or pulp derived from RR sugar beets were comparable to conventional (C) beets and pulps with respect to nutrient digestibility. Six varieties of sugar beets (5C+1RR), 5 varieties of fodder beets (4C+1RR) and 6 varieties of beet pulp (5C+1RR) were tested in 3 digestibility experiments with 7 sheep on each treatment. The daily dry matter intake was approx. 950 g (maintenance level), where hay with known digestibility and urea (assumed to be 100% digestible) was included in the diet in all experiments to obtain sufficient nitrogen and structural fiber. The digestibility was estimated for nutrients analyzed according to the Weende analysis, and for ADF, NDF and energy. The digestibility of organic matter varied between 91.8 and 94.6% for fodder beets, where RR variety showed the lowest value. For the sugar beets the variation was between 94.3 and 96.6%, with the RR variety resulting in a value of 94.4%. No significant difference was obtained between C or RR varieties for the main nutrients or energy in the sugar beet or fodder beet experiment. Organic matter digestibility for beet pulp varied between 84.7 and 89.5%, where the RR variety resulted in a value of 85.5%, and significant differences were found for main nutrients and energy digestibility between the highest and lowest C varieties. Organic matter digestibilities obtained for beets were slightly higher and for pulp slightly lower than tabulated values. From these experiments it is concluded that RR sugar and fodder beets, or pulp derived from RR sugar beets, have a nutrient digestibility which is within the range observed for conventional beets and pulps, indicating that feeding value is not influenced by genetic modification.

Key Words: Roundup Ready, Digestibility, Beets and pulp

1733 Growth performance of Xizhen cattle fed either urea or microbial treated rice straw. J. Luo¹, B. Wang*¹, X. F. Zhao², D. H. Tian¹, H. Y. Yang², and Q. Liu³, ¹Northwest Agricultural University, Yangling, Shaanxi, China, ²Animal husbandry bureau of Xixiang county, Xixiang, Shaanxi, China, ³Ankang Agricultural School, Ankang, Shaanxi, China.

In order to utilize the crop residues fully in the rural area of southern Shaanxi province in China, some processing methods were proposed to treat the low quality straw which could be used as animal feeds in dry winter season. The objectives of our study were to determine the nutritive values of microbial and urea treated rice straw, and investigate the growth performance of Xizhen cattle, a local cattle breed in Shaanxi province of China. Wheat bran (1%) was mixed with chopped rice straw (approximately 5 cm in length) before spreading urea and microbial cultures solution, treated mixture was pressed tightly into a square-shaped cement trench lined with a plastic film, after 20 days of fermentation, treated straw was used for feeding. 9 cows aged 1 to 1.5 year-old with 562 kg (± 28.8 kg) weighed BW were randomly divided into three groups: two groups received urea and microbial treated rice straw, the third group, as being the control, received untreated rice straw and 1% wheat bran supplement. The result showed that crude protein, fiber and fat percentage of urea and microbial treated rice straw were 5.5, 29.9, 1.54;

4.8, 30.0, 1.66% respectively; the average BW gain of cows in three groups was 1080, 1004, and 481 g/d in 88 days experimental period; cows fed urea treated rice straw had a greater ($P < 0.05$) BW gain than control, but was similar ($P > 0.05$) to cows fed microbial treated rice straw. The economic analysis suggested a higher profits for cows fed microbial treated rice straw. In conclusion, urea and microbial treated rice straw can be used as a basic diet for cattle during the winter feed deficiency.

Key Words: Urea or Microbial Treatment, Rice Straw, Nutritive Value

1734 Correlation between texture and *in situ* degradation of corn grain. C.E.S. Correa¹, R.D. Shaver², M.N. Pereira^{*1}, J.G. Lauer², and K. Kohn², ¹Universidade Federal de Lavras, Brazil, ²University of Wisconsin, Madison.

We hypothesized that corn kernel texture, measured as vitreousness and density, may be correlated with ruminal *in situ* degradation of corn kernel dry matter and starch. Fourteen American hybrids were harvested at half milk line, black layer, and mature (3-wk past black layer) stages and 5 Brazilian cultivars at maturity. Corn kernel samples were dried at 58 °C for 48 hours; vitreousness was determined by manual dissection of the vitreous endosperm and density was measured using a picnometer. Vitreousness ranged from 32.8 to 79.9 % of the endosperm and density from 1.124 to 1.292 g/cm³ of grain. The correlation between vitreousness and density was 0.87. A near infrared (NIR) curve generated from ground corn kernels had an RSD of 0.86 for vitreousness and 0.77 for density. The NIR technology may be useful for evaluating large corn data sets for differences in kernel texture. A sub-sample of 18 hybrids were ground through a 4 mm mesh screen and incubated *in situ* in 3 ruminally-cannulated Holstein cows in 3 separate non-concurrent trials. Ruminal degradation parameters were determined by non-linear regression for each cultivar. Effective dry matter (EFDM) and starch (EFST) degradation were estimated assuming a ruminal fractional passage rate of 8 %/h. For the 18 hybrids the correlation between kernel texture and effective degradation is reported. We conclude that corn kernel dry matter degradation is a good predictor of starch degradation, allowing for analytical cost savings. Kernel vitreousness and density were negatively associated with ruminal degradation within this corn population.

	Vitreousness	Density	EFDM
EFDM	-0.88	-0.83	
EFST	-0.91	-0.85	0.99

Key Words: Corn, Starch, Ruminal degradation

1735 Comparative dry matter degradation in rumen of cull chickpeas, soybean meal and sorghum grain using nylon bag technique in rumen of sheep. J.F. Obregon^{*1} and R. Barajas¹, ¹FMVZ- Universidad Autonoma de Sinaloa, Culiacan, Sinaloa Mexico..

To determinate the comparative dry matter degradation in rumen of cull chickpeas, soybean meal and sorghum grain using nylon bag technique in rumen of sheep, an experiment was conducted. Were used three sheep (Pelibuey, males; BW = 34 kg) fitted with canula in rumen. The animals were fed with a 17% CP and 3.34 Mcal DE/kg diet, containing sudan grass hay 18%, sorghum grain 30%, cull chickpeas 30%, canola meal 10.2%, sugar cane molasses 9%, urea 0.6%, and mineral premix 2.2%. Pairs of nylon bags (12 x 18 cm) containing five grams of ground chickpeas (CHP), soybean meal (SBM) or sorghum grain (SGG) were placed in rumen, and incubated by 2, 4, 6, 8, 12, 16, 20 and 24 hours. After removed from rumen, residual DM content was determinate. Solubility was obtained placing the bags in a 0.15 N NaCl solution. Kinetics parameters A, B and C were calculated. Rate of passage of small particles (K) was estimated as 0.02 to calculate the effective degradability of dry matter in rumen. Solubility of CHP-DM was 26% lower ($P < 0.01$) than SBM-DM (17.83 vs. 24.05%). While sorghum-DM solubility represented 6.9% of SBM-DM solubility (24.05 vs. 1.7%). At 12 hours incubation time, ruminal degradation of CHP-DM was 33% higher ($P < 0.01$) than SBM-DM (72.71 vs. 54.84%). Sorghum-DM degradation was 54% lower ($P < 0.01$) than CHP-DM (72.71 vs. 33.09%). After 24 hours incubation, CHP-DM was 43% more degraded in rumen ($P < 0.01$)

than SGG-DM (95.9 vs. 67.2). Effective degradation of chickpeas dry matter was calculate in 92.3%. Rate of disappearance of DM from nylon bags were: 0.083%/h ($R^2 = 0.98$), 0.027%/h ($R^2 = 0.99$) and 0.027%/h ($R^2 = 0.99$) for CHP, SBM and SGG, respectively. It is concluded, that chickpeas dry matter is highly degraded in rumen and that is disappearance rate is faster than soybean meal and sorghum grain dry matter in rumen of sheep.

Key Words: Chickpeas, Degradability, Sheep

1736 Ruminal *in situ* degradation was lower for Brazilian than United States corn grains. C.E.S. Correa¹, R.D. Shaver², M.N. Pereira^{*1}, J.G. Lauer², and K. Kohn², ¹Universidade Federal de Lavras, Brazil, ²University of Wisconsin, Madison.

Flint versus dent endosperm is predominant in Brazilian (BRA) versus United States (US) corn markets. We evaluated differences in corn kernel texture between countries and its effect on ruminal *in situ* starch degradation. Fourteen US and 5 BRA hybrids, cultivated in their respective countries and harvested at maturity, were ranked by vitreousness as measured by manual dissection of vitreous endosperm. Within each country three hybrids were chosen to represent the extremes of vitreousness. Mean vitreousness of US hybrids was 47.0% (42.3, 49.6 and 53.9%) and 73.2% (65.3, 68.7 and 78.3%) for BRA hybrids. Corn kernels were ground through a 4 mm mesh screen and incubated *in situ* in 3 ruminally cannulated Holstein cows. Ruminal starch degradation parameters were determined by non-linear regression. Effective starch (EFST) degradation was estimated assuming a fractional passage rate of 8 %/h. In a second *in situ* trial, two US hybrids of high (55.2%) or low (36.3%) vitreousness were harvested at half milk line, black layer, and mature (3-wk past black layer) stages. Average EFST was 78.7% for the low and 67.4% for the high vitreousness hybrids ($P < .001$). The hybrid with high vitreousness had a greater decrease in ruminal starch degradation with advancing maturity ($P < .01$ for the interaction between hybrid and maturity). Starch digestion may be a major concern in BRA hybrids, especially in situations of delayed harvest.

	US hybrids	BRA hybrids	P value
Fractional rate of starch degradation (%/h)	19.4	7.0	<.001
Rapidly degraded A fraction (% of starch)	31.0	6.1	<.001
EFST (% of starch)	77.4	48.5	<.001

Key Words: Corn, Starch, Ruminal degradation

1737 Evaluation of water powered liquid metering system to provide molasses for lactating dairy cattle on pasture. J.L. Amick*, L.D. Muller, D.R. Buckmaster, H.D. Karsten, T.W. Cassidy, and E.M. Seconi, *The Pennsylvania State University, University Park, PA.*

Grazing lactating dairy cattle were fed isoenergetic ratios of concentrate (C) or concentrate (minus 1.05 kg DM) + liquid molasses (1.05 kg DM/cow/day) (CM) to evaluate the effectiveness of a liquid metering system powered by pressurized water to deliver molasses to grazing dairy cattle. Fourteen Holstein cows (97 DIM, 44 kg milk/day, 567 kg BW, 2.6 BCS) grazed alfalfa (*Medicago sativa* L) (20.2% NDF, 28.4% CP, 67.2% IVDMD) in a single reversal design with 14 days/period. Cows grazed in a rotational grazing system with adjacent plots where the C received water and the CM received water containing the molasses. Water consumption was greater for CM than for C (79.4 vs. 62.5 L/cow/day. $P < 0.05$) and resulted in 1.05 kg/cow/d molasses DMI. Cows were milked twice daily and individually fed concentrate after each milking. Milk production (33 kg/d) and composition (2.6% fat, 2.8% protein, 13.8 mg/dl MUN) did not differ ($P > 0.05$) between groups. Feed intake, determined using Cr₂O₃, did not differ ($P > 0.05$) between treatments (22.8 kg/cow/d). Blood concentrations of urea nitrogen (16.7 mg/dl), glucose (66.1 mg/dl) and NEFA (207 µeq/L) were not different ($P > 0.05$). The water-powered liquid metering system increased water intake, provided molasses throughout the 24-hour grazing period, and effectively controlled liquid supplement intake. Milk production, milk

composition, DMI, and blood metabolites were not different when compared to feeding grazing cows a grain supplement without molasses.

Key Words: pasture, supplementation, molasses

1738 Effect of corn grain texture and maturity on ruminal *in situ* degradation. G.A. Caestine, M.N. Pereira*, R.G.S. Bruno, R.G. Von Pinho, and C.E.S. Correa, *Universidade Federal de Lavras, Brazil.*

Dent (AG 1051, AG 4051) and flint (AG 9012, Tork) corn cultivars were cultivated in five 7-m rows and harvested at early dent (ED), half milk line (HL), and black layer stages (BL). Each grain was frozen-cut into four pieces for ruminal incubation into 6 rumen-cannulated cows. The disappearance of dry matter over 24 hours (DEG24) and the residue of 72-hour (RES72) incubations were recorded. A sample was dried at 58 °C for 96 hours to determine dry matter content (DM) and vitreousness (Vitre) measured by manual dissection of vitreous endosperm. *In situ* data were analyzed within cow and least square means for each hybrid used to correlate *in situ* parameters with DM and Vitre. Linear and quadratic contrasts for maturity were evaluated. The quadratic decrease in ruminal digestion reflected a linear increase in Vitre and DM, factors beyond moisture and presence of hard endosperm may be involved in digestion responses. Correlation of DEG24 and DM was greater than with Vitre (-0.88 vs -0.61). However, correlations between Vitre and DEG24 were higher when performed within texture, and as high as with DM for dented corn. The harvesting window of flint corn is apparently shorter than for dented if starch digestion is a concern. Texture had a greater impact on ruminal digestion at the BL stage of growth.

	DEG24 (% of grain DM)	RES72 (% of grain DM)	Vitre (% of endosperm)	DM (% of grain)
Flint/ED	73.3	1.9	59.9	60.0
Flint/HL	65.0	3.7	67.0	64.5
Flint/BL	19.0	41.1	74.2	78.4
Dent/ED	86.2	1.2	38.2	54.5
Dent/HL	61.4	4.8	46.9	62.4
Dent/BL	42.3	16.9	47.9	74.2
SEM	2.8	1.1	2.7	2.6
Texture	<.001	<.001	<.001	.12
Maturity	<.001	<.001	.01	.001
T*M	<.001	<.001	.54	.82
Linear	<.001	<.001	<.01	<.001
Quadratic	.002	<.001	.45	.20

Key Words: Corn, Texture, Ruminal degradation

1739 Optimal inclusion level of a raw soybean hull-corn steep liquor pellet in diets for lactating dairy cows. J. M. DeFrain*¹, J. E. Shirley¹, E. C. Titgemeyer¹, A. F. Park¹, and R. T. Ethington², ¹Kansas State University, Manhattan, ²Minnesota Corn Processors, Inc.

Forty multiparous Holstein cows (255 ± 135 DIM; 28 ± 6 kg/d milk) were used in a randomized block design to determine the optimal inclusion level of a raw soybean hull-corn steep liquor pellet (SHSL). Cows were blocked by pretreatment ECM, BW, and BCS and assigned to one of five diets: 0, 10, 20, 30, or 40% SHSL (DM basis). Diet CP averaged 17%. The 0% SHSL diet contained 30.2% alfalfa hay (AH), 15.2% corn silage (CS), 30.7% corn, 9.4% whole cottonseed, 6% soybean meal (SBM), 4% expeller SBM, 1% wet molasses, and 3.5% vitamin/minerals. SHSL incrementally replaced up to 12.5% AH, 7.1% CS, 12.7% corn, and 7.2% SBM. Cows were fed diets for 11 d. Milk yield (2-d average) and milk composition were measured prior to initiation of treatment for covariate analysis and at the end of the trial. Blood was collected on d 11. A quadratic response (P = 0.01) was observed for DMI with cows fed 30% SHSL consuming the least. A significant cubic effect (P < 0.05) was observed for ECM yield and efficiency as cows fed 10, 20, or 40% SHSL produced more ECM, more efficiently than cows fed diets containing 0 or 30% SHSL. Percent fat, protein, and SNF in milk were not affected by diet, but corresponding yields (kg/d) responded cubically (P < 0.01), similar to ECM. MUN was higher for cows fed 40% SHSL than those

fed other diets. Concentrations of glucose and urea in plasma were similar among diets, but quadratic responses (P < 0.05) were observed for plasma Lys, Leu, Trp, Tyr, total essential amino acids, and total amino acids, which were all higher for intermediate levels of SHSL. These data indicate SHSL up to 40% of diet DM is an acceptable feedstuff for lactating dairy cows during short term feeding periods. Longer term studies are warranted. Based on efficiency of ECM production, 20% of diet DM was the optimal inclusion level for SHSL in diets fed to lactating dairy cows.

Key Words: Soybean hulls, Steep liquor, By-product

1740 Corn crop residue grazing effects on soil physical properties and soybean production in a corn-soybean crop rotation. J. R. Russell¹, J. T. Clark*¹, D. L. Karlen², W. D. Busby¹, L. J. Secor¹, B. Peterson³, C. R. Olsen¹, and S. C. Shouse¹, ¹Iowa State University, ²National Soil Tilth Laboratory, ³USDA Natural Resource Conservation Service.

To evaluate the effects of crop residue grazing by beef cows on soil characteristics and soybean yields, a 19.4-ha field near Atlantic, IA and 14.6-ha field near Chariton, IA were divided into four blocks of 6 paddocks. Twelve beef cows were allotted to graze five of the paddocks at 28-d periods beginning on October 15 and November 29 at the Atlantic and Chariton sites. Twelve grazing exclosures were placed in two transects within each grazed paddock. Precipitation and soil temperature, bulk density, moisture content, penetration resistance, surface roughness, classification, topsoil depth, and crop residue cover were measured. Soil bulk density, moisture content, and penetration resistance in grazed paddocks were measured to a depth of 20.3 cm outside and inside grazing exclosures and expressed as the outside-to-inside ratio. In the subsequent growing season, soybeans were planted in replicate fields with disking or no tillage and yield determined at harvest. At the Atlantic site, the ratios of the soil bulk density outside to that inside grazing exclosures at a depth of 0 to 10.2 cm were greater (P < .06) in paddocks grazed in periods 1, 2, 3 and 5 and soil surface roughnesses were greater (P < .01) in paddocks grazed in period 5 than ungrazed paddocks. At the Chariton site, soil surface roughnesses (P < .01) were greater in paddocks grazed in periods 2, 3, and 4, ratios of penetration resistance to a depth of 10.2 cm outside to inside grazing exclosures were greater (P = .01) in periods 2, 4, and 5, and postgrazing residue covers were lower (P < .01) in all grazed paddocks than ungrazed paddocks. At both sites, soybean yields in the season following grazing did not differ between grazed and ungrazed paddocks. In stepwise multiple regressions using data from both sites, soybean yields (kg/ha) were predicted by soil clay % (y = 5672.65 - 112.73x; r² = .91).

Key Words: Corn crop residues, Grazing, Soil

1741 Dynamics of the nutrients in the gastrointestinal tract: Validation of the Cornell system for bovine fed with sugar cane based diets. E. S. Pereira*¹, A. C. Queiroz², S. C. Valadares Filho², L. F. Miranda³, and A. M. V. Arruda¹, ¹Universidade Estadual Oeste Paran, ²Universidade Federal Viosa, ³Universidade Federal Minas Gerais, Brazil.

The objective of this work was to validate the predictions with base in the estimates of the dynamic ruminal and post-ruminal parameters of the nutrients and of the microbial growth at the rumen level, using the equations that compose the submodel Cornell system relative to the gastrointestinal tract. Four Holstein-Zebu young bulls with average 300 kg LW, rumen and abomasal fistulated were allotted to 4 x 4 Latin square design in a 2 x 2 factorial arrangement. The animals were fed with sugar cane based, diets, supplemented with two nitrogen sources (urea or poultry litter) and two daily levels of *Sacharomyces cerevisiae* addition (0 or 10 g/animal). The indigestible neutral detergent fiber (NDF) and chromium mordant sugar-cane NDF were used as internal and external markers, to estimate the daily fecal production and the ruminal particle passage rates. The dynamics of the nutrients was based on the determinations of the total nitrogen flow and of the of abomasal nitrogen flow of microbial origin, of the total and NDF digested in the rumen. These variables were also predicted from the model described in the Cornell system, for validation of its estimates. The microbial yield was not influenced by the nitrogenous sources or by *Sacharomyces cerevisiae* addition. The simulation of the Cornell system resulted in overestimation of the total ruminal carbohydrates digestion (51%) and NDF degraded in the rumen (47%), the nitrogen flow of microbial origin (86%) and

underestimated the total nitrogen flow (73%). The CNCPS model did not present a realistic prediction of the dynamics of the nutrients in the gastrointestinal tract.

Key Words: Microbial efficiency, CNCPS system, Rate of passage

1742 Determination of the protein and carbohydrates fractions, and in vitro degradation rates of the sugar cane, poultry litter and cottonseed meal. E. S. Pereira^{*1}, A. C. Queiroz², S. C. Valadares Filho², L. F. Miranda³, and A. M. V. Arruda¹, ¹Universidade Estadual Oeste Parana, ²Universidade Federal Viosa, ³Universidade Federal Minas Gerais, Brazil.

The objective was to fractionate and examine the degradation kinetics of the nitrogenous compounds and the carbohydrates of the sugar cane, poultry litter and cottonseed meal. The non-protein nitrogenous compounds, soluble and insoluble nitrogen in borate-phosphate buffer, neutral detergent and in acid detergent insoluble protein nitrogen were analyzed for the determination of the nitrogen fractions. The degradation rates of the protein fractions were obtained from the in vitro incubation of the feeds with proteases isolated from ruminal fluid. The total carbohydrates, and the fractions C, B2 and the soluble neutral detergent components were calculated for the determination of the carbohydrates using the Cornell system. The potentially degradable (B2) and undegradable (C) fractions of the neutral detergent fiber, corrected for ash and protein, the lag dynamic rates, of degradation and of specific microbial growth, from the fraction B2, were determined. The coefficient of degradability and the NDF ruminal repletion effect of the feeds, were also determined. The values of 71.01; 45.80 and 71.66% of the fraction B2 of the nitrogenous compounds were observed for sugar cane, poultry litter and cottonseed meal, respectively. The poultry litter stood out for the highest B3 and C fraction (23.57 and 10.11%). The B3 fraction degradation rates were of 0.03; 0.031 and 0.09 h⁻¹ for sugarcane, poultry litter and cottonseed meal, respectively. The fraction C of the carbohydrates varied of 22.74; 28.00 and 32.64% for the three feeds, respectively. The sugar cane presented high soluble components fraction (35.99%), however presented low digestion of the potentially degradable fiber (3.41% h⁻¹) and a significant repletion effect (6.6 h⁻¹). The feeds, sugarcane and poultry litter present low nutritional value to meet the ruminal microorganisms and of the host requirements.

Key Words: Carbohydrate, Protein, Rumen

1743 Effect of whole or ground cottonseed on apparent digestibility of finishing diets for sheep. A. Estrada^{*1}, J.F. Obregon¹, R. Barajas¹, and B. Valenzuela¹, ¹FMVZ-Universidad Autonoma de Sinaloa (Mexico).

The objective of this study was to determine the apparent digestibility of whole or ground cottonseed in finishing diets of sheep. Four sheep (Pelibuey, males, BW=25.9 kg) were used in a crossover design experiment. The treatments were: 1) ground cottonseed 20%(GCS), sudan grass 12%, sorghum grain 50%, canola meal 5.2%, sugar cane molasses 10%, urea 0.8%, and mineral premix 2% (15.3% CP and 3.47 Mcal DE/kg); 2) A diet similar to control but containing whole cottonseed 20% (WCS) instead of ground cottonseed. The animals were housed in metabolic crates (1.2 x 0.6 m) and were fed twice daily (3.1% of BW). After a 10d dietary adaptation period, samples of food and total fecal production were collected across 4 d. Samples were oven dried (110 °C, 24 h), and DM and CP (N x 6.25; Kjeldhal) analyses were performed. Dry matter intake and crude protein intake were not affected (P>0.10) by treatment. Dry matter excreted in feces increased (P<0.04) in 14.7% with whole cottonseed treatment (170 vs. 195 g/day). Crude protein excreted in feces was not affected by treatments (P>0.10) with mean value of 22.3 g/day. The inclusion of whole cottonseed decreased (P>0.04) by 4.4% the apparent digestibility of diet dry matter (75.2 vs. 71.9%). Crude protein digestibility was not affected (P>0.10) by processing of cottonseed (P>0.10). The mean of experiment was 78.9%. DE of the diet was 4.4% lower (P<0.01) in whole cottonseed than in ground cottonseed diet (3.21 vs. 3.07 Mcal DE/kg). Observed/expected DE was lower (P<0.01) in WCS than in GCS diet (0.88 vs. 0.93). DE content of whole cottonseed was estimated to be 3.53 Mcal/kg. Whole cottonseed possesses a lower nutritional value than ground cottonseed for sheep fed finishing diets, and that WCS-DE content is near of 3.5 Mcal/kg.

Key Words: Cottonseed, Digestibility, Sheep

1744 Effect of feeding foliage of a multipurpose tree (*Enterolobium cyclocarpum*) on ciliate protozoa and ruminal fermentation in sheep. K. M. Koenig^{*1}, M. Ivan¹, B. Teferedenge², L. M. Rode¹, M. Ibrahim³, D. P. Morgavi¹, and C. J. Newbold², ¹Agriculture and Agri-Food Canada, Research Centre, Lethbridge, AB Canada, ²Rowett Research Institute, Aberdeen, Scotland, ³CATIE, Turrialba, Costa Rica.

The effect of feeding foliage of *Enterolobium cyclocarpum* on ciliate protozoal numbers and rumen fermentation was measured in three groups of five ruminally cannulated wethers with either no ruminal protozoa (fauna-free), a normal mixed protozoal population, or genera of *Entodinium* as a single species rumen fauna. Repeated measurements were made on the sheep in two periods of 28 d. The control diet was a total mixed ration composed (DM basis) of barley silage (60%), and a barley grain and soybean meal pelleted concentrate (40%). The diet was offered twice a day and feed was restricted to 85% of ad libitum intake from d 12 to 28. In the second period, 200 g (93.7% DM) of *E. cyclocarpum* was substituted for an equal amount of diet DM offered at the morning feeding, and fed from d 16 to 28. Rumen contents were collected at various times over the last 5 d of each period (d 9 to 13 of *E. cyclocarpum* feeding) for measurement of volatile fatty acids, NH₃-N, and protozoal numbers, and then averaged for statistical analysis. Total protozoal numbers were lower in sheep faunated with a normal mixed protozoal population compared to sheep monofaunated with *Entodinium spp.* Feeding the foliage of *E. cyclocarpum* tended (P = 0.065) to reduce protozoal numbers by 25%. Total volatile fatty acid concentration was higher and NH₃-N concentration lower in sheep fed *E. cyclocarpum* suggesting that ruminal digestion was not compromised and that the turnover of microbial protein in the rumen was reduced by the anti-protozoal effect of *E. cyclocarpum*. In a second experiment, eight ruminally cannulated sheep with a normal mixed ruminal protozoal population were fed the control diet or the control diet supplemented with 200 g *E. cyclocarpum* for a period of 42 d. Rumen contents were collected 2 h after feeding for protozoal enumeration to determine the persistence of the anti-protozoal effect of *E. cyclocarpum*. Protozoal numbers were reduced in sheep fed *E. cyclocarpum* from d 5 to 11, and then protozoal numbers recovered to the levels in the control animals. In conclusion, feeding the foliage of *E. cyclocarpum* reduced ruminal ciliate protozoal numbers, but the effect was transitory.

Key Words: protozoa, defaunation, ruminal fermentation

1745 Effect of subacute ruminal acidosis on in situ digestion of mixed hay in lactating dairy cows. J.C. Plaizier^{*1}, J.E. Keunen², J.-P. Walton², T.F. Duffield³, and B.W. McBride², ¹Department of Animal Science, University of Manitoba, ²Department of Animal and Poultry Science, University of Guelph, ³Ontario Veterinary College.

It is expected that subacute ruminal acidosis (SARA) reduces fiber digestion, since low rumen pH (< 6) reduces growth yield and increases maintenance requirements of fibrolytic microflora. Additionally, low rumen pH might reduce the effect of fibrolytic enzymes. Previous investigations on the effect of rumen pH on fiber digestion have been conducted in vitro. The extent of NDF digestion determined in situ is generally greater than that determined in vitro. Hence, results from earlier in vitro studies might not be fully indicative for the effect of SARA on ruminal digestibility. Using a previously developed nutritional model to induce low rumen pH, the effect of SARA on rumen DM and NDF degradability of mixed hay was determined. SARA was induced by replacing 25% of the ad libitum DM intake of total mixed ration (TMR) with grain pellets (50% wheat/50% barley). Rumen pH was measured continuously using in-dwelling probes. In situ degradability was determined by incubating nitrogen free polyester bags with a pore size of 50 microns containing 2 g of ground dried hay in the rumen for 3, 6, 12, 24, 48 and 72 h. The nutritional model resulted in a substantial drop in rumen pH. Rumen pH in control cows was lower than that normally observed in lactating dairy cows. This was most likely due to the absence of bicarbonate from the TMR. The model had a much larger effect on the time below pH 6 and time below pH 5.6, than on average daily rumen pH (see table below). Hence, the latter two measures are more indicative of SARA than average daily rumen pH. The model resulted in a large reduction of in situ degradability of DM and NDF. NDF degradability was more affected than DM degradability (see table below). This study suggests that induction of SARA by excess feeding

of wheat/barley pellets reduces the ruminal digestion of DM and NDF from mixed hay substantially.

	Treatment			
	SARA	Control	SE	P
Avg. rumen pH	5.87	6.08	0.04	< 0.05
Time < pH 6 (min/d)	916	547	63.4	< 0.005
Time < pH 5.6 (min/d)	353	152	31.9	< 0.001
DM 24 h degr. (%)	52.9	56.4	0.84	< 0.05
DM 48 h degr. (%)	59.6	64.1	0.46	< 0.01
NDF 24 h degr. (%)	21.8	27.2	1.32	< 0.05
NDF 48 h degr. (%)	30.9	39.5	1.05	< 0.01

Key Words: Sub-acute ruminal acidosis, Fiber digestibility, Dairy cows

1746 Diets with high non-fiber carbohydrate and different solubilities for Llamas (*Lama glama*): effects on digestive activity in compartment 1 of the digestive system. M. Sol Morales^{*1}, R. Cabrera¹, A. Lopez¹, C. Carvajal¹, J. Gutierrez¹, and M. Goic¹, ¹Facultad Ciencias Veterinarias y Pecuarias, Universidad de Chile, Santiago, Chile.

A 2x2 latin square experiment was used to characterize digestion of high carbohydrate diets in llamas. Two female llamas, cannulated in compartment 1 (C1), were fed diets containing 40% alfalfa hay; carbohydrate sources differed in solubility. Diet 1 (D1, high degradation rate): beet molasses and oats (12 and 48% of diet DM) and Diet 2 (D2, low degradation rate): dried beet pulp and corn grain (21.7 and 32.3% of diet DM). Both diets had 3.34 Mcal/kg of DE, and NFE/CF ratio of 3.46 to assure bacterial protein synthesis (Hagemeister et al, 1981). Contents of CP and NDF were 13.6 and 34.3, and 11.6 and 41.9 (%) for D1 and D2. The diets were ground (5mm) and fed for 2 h/day. Each experimental period consisted of 15 days as adaptation period, and sampling at days 16, 18 and 20. In sacco 24 h DM degradability (DMD) (Mehrez and Orskov, 1977) was determined simultaneously with sampling of C1 content at 0, 1, 2, 4, 8 and 12 h after feeding to measure pH, VFA and NH₄ concentrations. The DMD at 24 h (%) assessed by Orskov and MacDonald (1979) was 73.9 and 72.7, and the a, b and c parameters of the DMD curve were: 59.45, 22.44, 0.043 and 24.15, 55.59, 0.086 respectively for D1 and D2. The parameters of the C1 (D1 and D2, respectively), were: pH, 7.00 and 6.95; total VFA (mM), 54.0 and 49.4; acetate, 39.9 and 34.9; propionate, 8.5 and 7.0; butyrate, 7.6 and 5.9 and NH₄, 16.9 and 16.4 (mg/dl) were not affected (P>0.05) by the diets. Only pH and NH₄ were different (P<0.05) with hour after feeding. Although there were no differences in utilization of these carbohydrate sources by Llamas, the high buffer capacity of C1 was clearly shown by the pH values obtained (lowest values occurring at 2h after feeding were 6.6 and 6.9 for D1 and D2, respectively). Excessive foaming occurred in one llama fed with D1. These results extend the data base for digestion in llamas from that reported last year evaluating mixed forage diets in llamas. FONDECYT Project 1980-769

Key Words: Llamas, Rumen

1747 Improving the nutritional value of oat hulls for ruminant animals: Study of synergistic interaction between *Aspergillus ferulic acid esterase* and *Trichoderma xylanase* on release of hydroxycinnamic acids from oat hulls. P. Yu^{*1}, J.J. McKinnon¹, D.D. Maenz¹, V.J. Racz^{1,2}, and D.A. Christensen¹, ¹Department of Animal and Poultry Science, University of Saskatchewan, Canada, ²Prairie Feed Resource Centre Inc., Canada.

Oat hulls, a byproduct from the milling process, contain relatively high amounts of hydroxycinnamic acids, mainly *p*-coumaric (PCA: 4-hydroxy-cinnamic) and ferulic (FA: 4-hydroxy-3-methoxycinnamic) acids. These components are believed to be inhibitory to oat hull biodegradability by rumen microorganisms. Previous research has shown that release of FA and PCA by a novel enzyme - *Aspergillus ferulic acid esterase* (A-FAE) was dependent upon particle size ($\leq 250 \mu\text{m}$) of oat hulls and the presence of *Trichoderma xylanase* (T-XYL). In this paper, a further study of the synergistic interaction between A-FAE and T-XYL at different levels (A-FAE at 13 mU, 800 mU and 409.6 U/assay; T-XYL at 1 U, 256 U and 4096 U/assay) on the quantitative release of FA and PCA from oat hulls was carried out. Total alkali-extractable FA and PCA in the oat hulls used in this study were 3.83 $\mu\text{g}/\text{mg}$ and

5.21 $\mu\text{g}/\text{mg}$, respectively. The results indicated that relative to A-FAE alone, the synergistic action of A-FAE and T-XYL was superior in causing the release of FA, indicating that T-XYL is important in acting with A-FAE in the degradation of feruloyl-polysaccharides of oat hulls. Averaged across FAE concentrations, increasing T-XYL level from 1 U to 256 U to 4096 U/assay resulted in an increase (P<0.001) in FA release from 5.6 to 15.0 to 37.5% and PCA from 2.7 to 5.6 to 7.8%, respectively. In contrast, averaged across T-XYL concentrations, increasing A-FAE from 13 mU to 800 mU to 409.6 U/assay resulted in the release of FA and PCA being only slightly increased from 17.5 to 18.6 to 22.0% and from 4.6 to 5.0 to 6.6%, respectively. There was no extensive release of PCA by A-FAE in both the absence and presence of T-XYL, indicating a specificity of A-FAE which only efficiently releases FA and not PCA from oat hulls. Polynomial regression indicated that T-XYL had significant (P<0.001) linear and quadratic effects on FA release (R² 0.91 and 0.89, respectively). This study suggests that a low level of A-FAE (13 mU) with a high level of T-XYL (4096 U) is able to sufficiently break the ester linkage between FA and the attached sugar, releasing FA from oat hulls. This action which causes disruption of crosslinks has the potential to improve hydrolysis of the remaining polysaccharides by rumen micro-organisms which, in turn, would improve rumen degradability of oat hulls.

Key Words: Hydroxycinnamic acids, Ferulic acid esterase, Oat hulls

1748 Effect of supplementation on rate of neutral detergent fiber degradation in forages measured *in situ* and by rumen evacuation. M.R. Weisbjerg^{*}, P. Lund, and T. Hvelplund, Danish Institute of Agricultural Sciences, Denmark.

Forage neutral detergent fiber (NDF) digestibility is highly variable depending on type and maturity of forage and ration composition. The aim of these experiments was to estimate rate of degradation (k_d) for digestible NDF (dNDF) for different forages with and without concentrate supplementation, and to compare the *in situ* method with the rumen evacuation method (REM), as REM is believed to give true values. Four forages; early cut grass silage (ECGS), late cut grass silage (LCGS), whole crop barley silage (WCBS) and grass hay (GH) were compared in two 4x4 Latin squares using rumen, duodenal and ileal fistulated dairy cows. Forages were fed ad libitum, as the only feed in exp. 1, and in exp. 2 supplemented with low fiber concentrates (kg DM/d; 4.5 wheat flour and 1.3 soybean meal). *In situ* k_d of dNDF was estimated using a degradation model including lag time. k_d based on REM was calculated as rumen disappearance of dNDF divided by rumen dNDF pool. Rumen pool was the mean from three different evacuation times over the day. Neutral detergent fiber contents in forage DM were 47, 61, 47 and 65%, and potential NDF digestibilities (21 d rumen *in situ* incubation) were 90, 78, 72 and 80% for ECGS, LCGS, WCBS and GH, respectively. Concentrate supplementation reduced k_d for dNDF measured by REM from 5.4, 3.4, 2.8 and 2.9 ± 0.9 %/h to 3.0, 3.1, 1.8 and 2.3 ± 0.3 %/h for ECGS, LCGS, WCBS and GH, respectively. In contrast *in situ* k_d for dNDF increased by supplementation. The *in situ* method slightly overestimated k_d in unsupplemented diets compared to REM, and the *in situ* k_d overestimation thus became more pronounced in supplemented rations. The negative effect of supplementation on k_d for dNDF found using REM was supported by the reduction in total tract NDF digestibilities due to supplementation from 81, 64, 54 and 62 ± 3 % to 70, 63, 37 and 52 ± 4 % for ECGS, LCGS, WCBS and GH, respectively. This indicates that the REM method gives reliable results but the *in situ* method overestimates k_d for dNDF especially in supplemented rations.

Key Words: NDF, Degradation rate, Rumen evacuation

1749 Mean ruminal retention time of fiber measured using indigestible neutral detergent fiber or ytterbium-labelled feed. P. Lund^{*}, M.R. Weisbjerg, and T. Hvelplund, Danish Institute of Agricultural Sciences.

It is well known that a long mean ruminal retention time (MRT) improves digestibility of fiber. However this may also restrict feed intake. Six forages; early cut grass silage (ECGS), late cut grass silage (LCGS), whole crop barley silage (WCBS), grass hay (GH), maize silage (MS) and alfalfa hay (AH) were compared using fistulated dairy cows in 4 Latin square experiments (A,B,C,D). Forages were fed ad libitum as the only feed (A, C) or supplemented (B, D) with (kg DM/d; 4.5 wheat flour and 1.3 soybean meal). Mean ruminal retention time was determined based

either on rumen pool of indigestible NDF (INDF) divided by duodenal flow of INDF; or on duodenal concentration of ytterbium (Yb) fitted to a two compartment mathematical model with age-dependency in the first compartment (G3G1), subsequent to a pulse dose of Yb-labelled neutral detergent fiber (NDF) from the respective feeds. Supplementation seemed to decrease MRT based on Yb-labelled feeds, whereas the results were less conclusive based on INDF, where supplementation seemed to increase MRT for LCGS and WCBS. Though both methods predicted the highest MRT for unsupplemented GH and the lowest MRT for supplemented MS and AH, correlation between the two methods was moderate ($r=0.61$, 60 obs.). As INDF in contrary to NDF is an ideal nutritional entity, the INDF method is believed to give true values for MRT of INDF and also good estimates for MRT of NDF. Mean ruminal retention time calculated based on Yb-labelled feed was underestimated compared to MRT of INDF. This indicates a migration of Yb from the particulate matter to the liquid pool and from large to small particles in the rumen. Therefore, results from the Yb-method should not be used as absolute values, but are useful to describe the age-dependency of passage.

Method	INDF	INDF	Yb	Yb
Supplementation	No	Yes	No	Yes
Experiment	A (± 20)	B (± 10)	A (± 3)	B (± 3)
ECGS	85	70	46	40
LCGS	63	80	47	41
WCBS	55	73	42	44

Experiment	C (± 10)	D (± 4)	C (± 3)	D (± 2)
GH	90	80	49	40
MS	54	41	41	36
AH	70	53	44	32

Key Words: Mean ruminal retention time, Rumen evacuation, Ytterbium

1750 Effects of physically effective fiber on chewing activity and rumen fermentation of dairy cows fed barley-based diets. W. Z. Yang^{*1}, K. A. Beauchemin¹, and L. M. Rode², ¹Agriculture and Agri-Food Canada, ²Bioavance Technologies Inc.

Dietary factors that alter the intake of physically effective fiber (peNDF) were evaluated for their effects on chewing activity and rumen fermentation using a double 4 x 4 Quasi-Latin square design with a 2 x 3 factorial arrangement of treatments. The dietary factors were: kernel thickness of processed barley grain, coarse (1.60 mm) or flat (1.36 mm); forage to concentrate ratio (F:C), low (35:65) or high (55:45); and forage particle size, long (7.59 mm) or short (6.08 mm). Eight lactating cows were offered ad libitum access to a total mixed diet (TMR). The peNDF contents in the diets were measured as the total proportion of the sample retained on both sieves of the Penn State Particle Separator (PSPS) or as the proportion retained on a 1.18 mm screen as proposed by Mertens (1997; JDS 80:1463). The peNDF contents in the diets ranged from 9 to 14% using the PSPS, and were double using the 1.18 mm screen. Higher intakes of peNDF due to higher F:C or longer forage particle size increased chewing time. However, increased intake of peNDF due to grain processing had minimal effect on chewing time. Intakes of peNDF measured by both methods were correlated ($r^2=46$, $P<0.01$) to chewing activity. Mean ruminal pH was lower for cows fed flatly rolled barley than for cows fed coarsely rolled barley with no effect of F:C ratio or forage particle size. No correlation was observed between the intake of peNDF and ruminal pH regardless of the method used. Although contents of ruminal VFA were not affected by the dietary factors measured, the intake of peNDF was correlated positively to acetate proportion ($r^2=52$, $P<0.01$) and negatively to propionate proportion ($r^2=-42$, $P<0.02$). These results indicate that peNDF content of the diet is a reliable indicator of chewing activity and VFA profile but not a good indication of ruminal pH. Both methods (PSPS or 1.18 mm screen) can be used to accurately measure peNDF of feeds fed to dairy cows.

Key Words: Effective Fiber, Chewing Activity, Rumen Fermentation

1751 The effect of copper oxide bolus administration on forage fiber digestibility in growing steers. J. D. Arthington* and W. F. Brown, Range Cattle Research and Education Center, University of Florida, Ona.

The objective of this study was to evaluate the effect of an intra-ruminal bolus containing copper (Cu) oxide needles (Copasure; Animax Ltd.,

Columbus, OH) on forage fiber digestion. Eight steers were randomly assigned to receive either a single bolus of Cu containing 12.5 g of Cu oxide needles (B; n=4) or no bolus (NB; n=4). During the 39-d study all steers were individually offered ground limpgrass hay (8.6 ppm Cu) in quantities sufficient to ensure ad libitum access. On d12 (Period 1; P1) and d33 (Period 2; P2) steers were placed in metabolism crates and total forage offered, refused, and fecal production were collected for 7d. Compositated samples of forage offered, refused and feces for each steer at each period were analyzed for DM, OM, NDF, ADF, and CP. All digestibility results were calculated on an OM basis. Liver biopsy samples were collected on d12 and d33. Cu oxide bolus administration resulted in an increase ($P<0.03$) in liver Cu at the start of P1 (556 vs. 296 ppm) and P2 (640 vs. 327 ppm). Total tract OM digestibility and OM intake expressed as a percentage of BW was not different ($P>0.10$) between treatments for either period. Although total fecal ash production was not different, B steers had increased ($P<0.03$) fecal Cu during P1 (164 vs. 21 mg Cu/d) and P2 (79 vs. 23 mg Cu/d). Fecal aluminum, iron, manganese, and zinc were not different for either period. Intake of NDF and ADF did not differ between treatments for either period; however, digestibility of NDF and CP were higher ($P<0.04$) for NB steers in P2 (62.2 vs. 57.1 and 50.2 vs. 43.4 % for NDF and CP digestibility, respectively). Digestibility of ADF tended to be higher ($P=.092$) for NB steers in P2 (57.3 vs. 52.3 %). These data suggest that although Cu oxide boluses are effective in increasing tissue Cu stores, they may contribute to lower forage fiber digestibility.

Key Words: Copper oxide, Fiber digestion, Steer

1752 Effect of forage particle length on ruminal liquid fraction kinetics and straw degradability of steers fed an oat straw diet. H. G. Gonzalez^{*1,3}, O. B. Ruiz², M. L. De la Vega², A. E. Orozco², A. C. Correa³, A. M. Perez³, V. V. Gonzalez³, H. C. Hernandez⁴, E. T. Rubio¹, and L. B. Gerlach⁵, ¹Medicina Veterinaria y Zootecnia-ICB, Universidad Autonoma de Ciudad Juarez, Mexico, ²Universidad Autonoma de Chihuahua, ³Universidad Autonoma de Baja California, ⁴Universidad Autonoma de Baja California Sur, ⁵Universidad de Sonora.

Four Hereford steers (300 kg) fitted with permanent rumen cannulas were used to evaluate the effect of 2 forage chop lengths: 2.5 cm (T1) and 10 cm (T2) on the ruminal liquid fraction kinetics and straw degradability. The animals were fed a basal oat straw diet and they were provided an alfalfa hay supplement (20%). Alfalfa was offered twice daily at 0800 and 1700 h. The estimation of liquid kinetics was made by using a system of equations. A dose of Co-EDTA was infused into the rumen, and ruminal fluid samples were taken from each animal at 0, 1.5, 3, 6, 9, 12, 16, and 24 h post-infusion. The ruminal degradation of straw was estimated by using the nylon bag technique and a non-linear model. Data was analyzed as a switchback design. The feed intake was *ad libitum*. It was observed a higher DMI ($P<.05$) of T1 than T2 (79.7 vs 70.8 g $kg^{-1} W^{.75}$). No differences ($P>.05$) were detected in ruminal volume (79.93 vs 87.7 L) between diets. Nevertheless, steers fed T1 had a faster ($P<.01$) mean time (9.48 vs 16.02 h), dilution rate (7.08 vs 4.36 % h^{-1}), flow rate (5.64 vs 3.82 L h^{-1}), and turnover rate (1.7 vs 1.04 times d^{-1}) than steers fed T2. No differences were detected in degradation rate. No differences ($P>.05$) were detected in ruminal straw degradation to water soluble fraction (constant a; 19.94 vs 20.22 %), and degradation rate (.0258 vs .0255 % h^{-1}) for T1 and T2 treatments. A significant difference ($P<.05$) was detected in potential degradation of b constant (31.04 vs 33.27 %) between T1 and T2, respectively. These results suggest that size of forage affects the kinetic of liquid fraction and DMI.

Key Words: Steers, Kinetics, Degradability rate

1753 Models for describing kinetics of fiber digestion in the rumen. F. O. Carrete-Carreón*, C. E. Cole, J. H. Matis, W. C. Ellis, and C. Lowe, Texas A & M University.

The objective of this research was to evaluate alternate, non-exponential models for describing the expected distribution of lifetimes in the rumen of undigested, U, potentially digestible NDF and its constituent entities, cellulose and hemicellulose. Models having non-exponential distribution of lifetimes of U were emphasized because of the variable content and rate of digestion of entities that comprise NDF. Four classes of models were evaluated for fit to observed lifetimes for U in the rumen. Types of models included: 1) a single exponential distribution of lifetimes for U (G1), 2) a single distribution of gamma distributed, age-dependent

lifetimes for U (GN where $N \geq 2$), 3) simultaneous distribution of GN and G1 lifetimes for U (GN+G1 and G1+G1) and 4) a heterogeneous distribution of exponential, GN, and other non-exponential distributions of lifetimes (GX) for U. The U in ryegrass (*Lolium perenne* L.) hay, cotton seed hulls, CSH, and a mixed diet of 60% CSH ground to pass a 2 mm sieve was determined in triplicate as the U remaining after 0, 2, 6, 12, 18, 24, 36, 48, 60, 72, 96, 144 and 240 h. *in situ* in two rumen cannulated cattle. Discrete time delays statistically different from zero ($P < 0.05$) were frequently resolved by the G1 model. In contrast, inclusion of non-exponential distribution of lifetimes, GN, or simultaneous distributions of lifetime, G1+G1 and GN+G1, accounted for the spectrum of observed lifetimes of U without a discrete time delay and resulted in superior statistical fit ($P < 0.05$). Models assuming an intermediate age-dependency for a single distribution, G2, or two simultaneous distributions of lifetimes, G2+G1 and G3+G1 yielded mean rates of digestion and estimates of indigestible proportions that were of intermediate magnitude. Differences in mean rate of digestion for cellulose and hemicellulose that comprise NDF substantiate the need for non-exponential distributed models of NDF digestion. The G2+G1 or G3+G1 model were least sensitive to initial starting values and most reliable in achieving convergence and are recommended as better descriptors of the process of digestion of NDF in the rumen.

Key Words: Fiber, Digestion, Models

1754 Rumen fluid dilution rates in cattle grazing tropical pastures. M.K. Bowen^{1,2}, S.R. McLennan¹, and D.P. Poppi², ¹Queensland Beef Industry Institute, Yeerongpilly Australia, ²University of Queensland, St Lucia Australia.

Low rumen dilution rates may contribute to the low efficiencies of microbial crude protein (MCP) production sometimes reported with cattle on tropical pastures. Fractional outflow rates (FOR) were estimated in cattle across a range of tropical pasture types and seasonal conditions in south-eastern Queensland, Australia. Eight rumen-fistulated, *Bos indicus* steers (initial BW 329 ± 26 kg) grazed six tropical pastures over 12 months, including: a native pasture (major species C4 Black speargrass (*Heteropogon contortus*) and Forest bluegrass (*Bothriochloa bladhii*)) in the early wet season (NPEW), dry season (NPD) and wet/dry transitional period (NPT); an introduced C4 pasture species, Creeping bluegrass (*Bothriochloa insculpta* cv. *Bisset* (BB)) in the mid wet season; and the introduced tropical legumes Dolichos lablab (*LabLab purpureus* cv. *Highworth* (LL)) and Butterfly pea (*Clitoria ternatea* cv. *Milgarra* (BP)). The temperate annual ryegrass (*Lolium multiflorum* cv. *Tetila* (RG)) was included for comparison. A single dose of chromium-ethylenediamine tetracetic acid (Cr-EDTA; ca.2 g Cr) was injected into the rumen and nine rumen fluid samples were collected over the next 48 h. There was a three-fold variation in FOR across pasture types, representing a range in marker retention times from 8.6-22.9 h. FOR values for early to mid season C4 grasses were similar to those for C3 species (tropical legumes and ryegrass) but that for mature native C4 pasture (NPD) was very low in association with the very low availability of green leaf. Rumen volume did not show the same variation. The results indicate considerable scope to manipulate dilution rate and potentially the efficiency of MCP synthesis.

	NPEW	NPT	NPD	BB	LL	BP	RG
Green leaf in pasture (%DM)	57.4	28.7	2.9	21.8	23.3	14.1	80.0
FOR (%/h) (s.e.)	10.8 (0.48)	7.6 (0.36)	4.5 (0.33)	9.5 (0.37)	11.7 (0.44)	8.4 (0.70)	9.3 (0.98)
Rumen volume (L.100/kg BW) (s.e.)	10.7 (0.96)	12.4 (0.51)	11.0 (1.07)	10.3 (0.40)	9.6 (0.68)	11.3 (0.38)	9.9 (0.29)

Key Words: Dilution Rate, Tropical Grasses

1755 The low forage feeding program, Totalac[®], increases milk production in high producing Holstein cows. P.A. Porter*, C.M. Luhman, and D.W. LaCount, Land O Lakes, Inc. and Cooperative Research Farms.

In 3 trials conducted over a 4-year period at one site, a low forage feeding program (25% of the ration DM) for high producing cows was evaluated; the trademarked name for the concentrate portion of these diets is Totalac[®]. The control rations were 50:50 forage: concentrate

ratio. The forage program in each trial was a 1:1 blend on a DM basis of corn silage and alfalfa silage; commercial applications of Totalac[®] have included hay. All treatments were fed to insure 10% feed refusal. Commercial applications have included hay. In Trial 1, a 4x4 Latin Square with 21-day periods, milk production was increased by 1.1 kg/d ($P < .05$) with the low forage program. Milk composition and DM intake were not different. In Trial 2, initiated at 100 DIM with a 15-week feeding period, the low forage program increased milk production by 3.7 kg/day, DM intake by 1.0 kg/day and milk crude protein content by .09% ($P < .05$). In Trial 3, initiated at day 1 of lactation with a 10-week feeding period, milk production and composition and DM intake were similar for control and low forage treatments. These data demonstrate that high producing dairy cows can be successfully fed low forage diets, even in early lactation. Long-term field usage (>300 days) has not indicated any adverse cow health effects. Totalac is registered trademark of Cooperative Research Farms.

Trial	1	1	2	2	3	3
Treatments	50:50 ¹	25:75	50:50	25:75	50:50	25:75
N/Trt.	8	8	21	22	17	42
DMI, kg/d	24.2	24.0	22.4 ^a	23.4 ^b	19.0	20.1
Milk, kg/d	29.5 ^a	32.6 ^b	36.7 ^a	40.4 ^b	37.4	38.8
3.5% FCM, kg/d	30.8	30.4	33.7	32.7	39.2	39.6
Milk Fat, %	3.89	3.44	3.03	2.53	3.81	3.63
Milk CP, %	3.53	3.46	3.23 ^a	3.32 ^b	3.01	3.06

^{a,b} Means within a trial and within a row differ at $P \leq 0.05$. ¹ Refers to F:C ratio.

Key Words: Totalac[®], Lactating Cows, Low Forage

1756 Growth rate of buffalo female calves on urea treated low quality roughages. Syed, H. Raza^{*1}, Shahid Mahboob², M.S. Khan¹, and Arshad Iqbal¹, ¹Faculty of Aniaml Husbandry, University of Agriculture, Faisalabad, Pakistan, ²Dept. Zoology, Govt. College, Faisalabad, Pakistan.

Eight buffalo female calves of almost similar age (5.20 ± 0.5 m) and weight (60.1 ± 1.5 Kg) were randomly allotted into two groups (A) and (B), each with four calves. The calves of group (A) were fed on ration containing untreated wheat straw (UWS) that served as control group. The group "B" was fed on ration containing 3% urea treated wheat straw (UTWS) for a period of six weeks in completely randomized design (CRD). The data on dry matter intake (DMI), daily live weight gain (DLWG), feed conversion ration (FCR) and digestibility of different nutrients viz., dry matter, (DM) crude protein (CP), crude fiber (CF), nitrogen free extract (NFE), other extracts (EE) and organic matter (OM) were recorded. The average values for DMI, DLWG, FCR and organic matter intake (OMI) were found to be 1.76 ± 0.65 and 2.63 ± 0.24 , 0.231 ± 0.04 and 0.332 ± 0.01 , 7.61 ± 0.32 and 7.92 ± 0.41 and 1.64 ± 0.06 and 2.42 ± 0.21 kg for treatments "A" and "B", respectively. The unit (%) increase in digestibility for urea treated wheat straw (UTWS) was found 9.51, 8.09, 13.68, 8.35, 12.46 and 10.35% for DM, CP, CF, NFE, EE and OM, respectively. Results suggested that urea treatment of wheat straw caused improvement in feed intake. The improvement in DMI and digestibility of various nutrients was due to the decrease in lignification, increase in N2 contents and more exposure of treated material for microbial attack for digestion breakdown.

Key Words: Buffalo, Growth, Roughages

1757 Utilization of gas production manometric system to estimate the rate of degradation of the dry matter (DM), neutral detergent fiber (NDF) and neutral detergent soluble fraction (NDS) of concentrate feeds by cattle, sheep and goat. J. C. Teixeira* and R. A. Santos, Universidade Federal de Lavras, Minas Gerais, Brazil.

The objective of this trial was to evaluate the degradation rate of the DM, NDF and NDS in ground corn, wheat, soybean and cotton meals, cottonseed and citrus pulp. The feeds were milled through 2.0 mm screen and the samples of 400 mg were incubated in vitro, in buffered rumen fluid obtained from 3 cows, 3 sheep and 3 goats. They were incubated whole sample, residue of neutral detergent. The gas production from NDS fraction was obtained by difference between the cumulative production of DM and NDF. The gas production (volume and pressure)

was measured after incubation time of 1, 2, 3, 4, 5, 6, 12, 18, 24, 30, 36, 48, 60 and 72 h, by manometric system. The volume of gas for all feeds was not different ($P < 0.01$) between cattle, sheep and goat (47.23; 52.18 and 49.56 ml respectively), and any interaction between species and fractions of the feeds was detected ($P > 0.05$). The colonization time of all feeds was not different ($P < 0.01$) between species (2.03; 2.32 and 2.93 h) too, but the NDF fraction had higher value ($P < 0.01$) than DM and NDS fractions (5.15; 1.14 and 0.99 h respectively). There was not difference ($P < 0.01$) between species to degradation rate of the tested feeds. However, the fraction NDS showed the best result ($P < 0.01$) for this variable; 10.54 versus 5.84 and 5.81 %/h to DM and NDF respectively. There was not interaction between fraction and feed ($P > 0.05$). This study shows that cattle, sheep and goat have the same behavior to degrade concentrate feeds. On the other hand, gas production technique is simple, fast and it can be used to estimate the degradation rate of feedstuffs, with success.

Key Words: Gas production, Degradation rate, Concentrate

1758 Comparison of the in vitro gas production and the nylon bag degradability techniques to measure degradation rate in cattle, sheep and goat. R. A. Santos and J. C. Teixeira*, *Universidade Federal de Lavras, Minas Gerais, Brazil.*

A study was conducted to compare in vitro gas production and nylon bag degradability techniques as methods of measuring degradation rate of ruminant feeds, and to determinate whether it is possible to predict in situ DM degradability with the gas production manometric technique. The samples of some roughage and concentrate feeds, were milled through 2.0 mm screen. They were utilized 3 animals of each specie to two techniques. The samples stayed incubated in the rumen for 72 h and the readings of in vitro cumulative gas production were made after incubation time of 1, 2, 3, 4, 5, 6, 12, 18, 24, 30, 36, 48, 60 and 72 h. The Pearson correlation coefficients between each pair of variables from in situ and gas production measurements were obtained using SAS. For all tested feeds there was significant ($P < 0.05$) correlation between in situ effective degradability and the volume of gas to all three species. Similarly, in situ DM disappearance was correlated ($P < 0.01$) with volume de gas. To sheep, the estimates of in situ effective degradability and DM disappearance were correlated ($P < 0.01$) with in vitro degradation rates. It can be concluded that the in vitro gas production is related to the degradation rate estimated by the in situ technique. Besides, the gas production technique with its simplicity of use and the possibility of processing a large number of samples in a short time, it will be important to find significant and valid correlation between in situ degradability and gas production parameters.

Key Words: Gas production, Degradation rates, In situ degradability

1759 The effect of rumen pH and forage type on in situ fiber hydrolysis in dairy heifers. C. Spackman*, R.L. Baldwin, E.J. DePeters, and M.L. Sweany, *University of California, Davis, CA.*

The objectives of this study were to determine the effects of rumen pH and forage type, on fiber hydrolysis in the rumens of Holstein heifers. Rumen and duodenal cannulated pregnant heifers (8) were sequentially fed four unbuffered diets, 100% oat hay (100%O), 40% oat hay:60% concentrate (40%O), 100% alfalfa hay (100%A), and 40% alfalfa:60% concentrate (40%A). Both oat hay (O) diets had a crude protein (CP) of 10% and both alfalfa hay (A) diets a CP of 20%. All animals were housed individually and fed twice a day at 8am and 6pm. After a 14d adjustment period to each diet, filter bags (ANKOM F57) containing samples of ground O or A to match the forage in that diet were incubated in the rumen. Bags were placed in the rumen at morning feeding and removed after 2,4,6,8,10,12,16, and 24h. After removal, bags were washed with water 6 times for 1 min in an ANKOM²⁰⁰ Fiber Analyzer at room temperature. Bags were then frozen until further analysis. Rumen pH was recorded every 15 min during the 24h incubation period by an indwelling pH probe inserted through the rumen cannula housed in the pocket of a harness worn by each heifer. Average pH values over the 24h for the four diets were 6.69, 6.38, 6.62 and 5.93 for 100%O, 40%O, and 100%A, 40%A respectively. A greater difference was seen between diets for range of pH values averaged across animals 5.99 to 7.21, 5.43 to 6.93 for 100%O and 40%O, and 5.88 to 7.11, and 5.13 to 6.79 for 100%A and 40%A. Dry matter (DM) loss from bags containing A incubated in

the rumen for 12h was reduced from 43.8% (100%A) to 33.3% (40%A) in response to concentrate. No difference was seen in the O bags with only 30% DM loss after 12h. Loss of DM from bags containing A rose to 54.9% on 100%A, and to 39.9% on 40%A after 24h. Increasing unbuffered concentrate in the diet resulted in a lower average rumen pH and a reduction in fiber hydrolysis for both forage types. Total fiber hydrolysis over 24hours was more reduced for A than O, suggesting that effect of rumen pH on fiber hydrolysis may vary with forage.

Key Words: pH, Rumen, Fiber

1760 Effects of Dietary Proportions of CP/Potentially Digestible NDF, PDF, upon Rates of Digestion, Turnover and Intake of PDF. C. A. Lowe*, W. C. Ellis, F. O. Carrete-Carreón, C. A. Marsh, and E. Moody, *Texas A & M University.*

It is hypothesized that insufficient yield proportions of rumen degraded CP, RDP, and potentially digestible NDF, PDF, limit the rate of digestion, ruminal turnover and intake of PDF. The objective of this experiment was to investigate effects of a wider range in CP/PDF than observed in previous studies. Three mature cattle with established rumen cannulae were fed mineral supplemented, mature bahia grass (*Paspalum notatum*) hay, *ad libitum*, with 0.0, 0.91, or 2.73 kg/d of cottonseed meal in a three by three Latin square design. Leaf and stem portions of the hay were separated, and labeled with different rare earth elements and consumed with a single meal in order to measure their ruminal turnover rate. Also, leaf and stem samples ground to pass a 2 mm screen were incubated in the rumen of the three cows during each period, for 0, 2, 6, 12, 18, 24, 36, 48, 60, 72, 96, 144 and 168 h *in situ* for determination of mean rate of digestion of PDF. The mean rate of digestion of PDF, PDFkd, was estimated by fitting a two-compartment age dependent, age-independent model to the profiles of undigested NDF *in situ*. PDFkd, for both leaf and stem, did not differ ($P = 0.14$), was unaffected by level of dietary protein and averaged 0.027/h. The mean of turnover rate, ke, did not differ for leaf and stem and was significantly ($P < 0.05$) and positively related to CP/PDF. Daily intake rate of PDF (g PDF/kg BW) was significantly and positively, $P < 0.05$, related to CP/PDF. Treatment means were 7.8^b, 8.6^{ab}, and 9.4^a g PDF/kg BW, for 0.0, 0.91, and 2.73 kg/d of cottonseed meal, respectively. Protein supplementation was not related to rate of *in situ* digestion. Thus, the hypothesized positive effects of dietary CP/PDF upon rates of ruminal turnover and intake of PDF were supported while the trend for positive effects on PDF was a non-significant ($P > 0.05$) trend.

Key Words: Rumen, Protein, Kinetics

1761 Effects of ensiling temperature and enzyme additives on the fermentation and in vitro rumen degradation of maize silage. D. Colombatto*¹, F. L. Mould¹, M. K. Bhat², R. H. Phipps¹, and E. Owen¹, ¹The University of Reading, UK, ²Institute of Food Research, Norwich, UK.

Forage maize (352, 447, 227 and 323 g/kg DM, NDF, ADF and starch, respectively) was ensiled in triplicate in 0.5 kg capacity silos, with or without addition of two enzyme preparations. Depol 40 (D, Biocatalyst Ltd, UK) and Liquicell 2500 (L, Specialty Enzymes and Biochemicals, USA) were added to provide relative xylanase activity levels of 7200, 14400, and 28800 units/kg forage DM. The silos were stored at room temperature (R, 15-20°C) for 120 d, or at 40°C for three weeks, then stored at R. Storage at 40°C decreased ($P < 0.05$) the mean pH of D-treated silages (3.71 vs. 3.47 for R and 40°C, respectively). No differences ($P > 0.05$) in the untreated silages (3.99 vs. 3.98) or in the L-treated silages (3.69 vs. 3.72). Starch contents were reduced ($P < 0.05$) by addition of D (252, 136, 102, and 82; 267, 190, 164, and 94 g/kg DM for control and D-treated silages at R or 40°C, respectively), in line with the high levels of α -amylase found in this preparation. NDF and ADF levels were increased ($P < 0.05$) as a result of starch hydrolysis, but this effect was only evident at R. NDF and ADF contents in L-treated silages were decreased ($P < 0.05$) (492 vs. 394, 249 vs. 198; and 489 vs. 392, 253 vs. 190 g/kg for NDF and ADF of control and L, at R or 40°C). As a result, L-treated silages showed an increase ($P < 0.05$) in starch (252 vs. 339 g/kg DM, and 267 vs. 347 g/kg DM for control and L-treated silages at R and 40°C). In vitro gas production and OMD dynamics were assessed using the Reading Pressure Technique. Rumen fluid was collected pre-feeding (0700 h) from two cows fed a maize silage-based TMR. Initial rates of gas production and OMD were decreased ($P < 0.05$)

in the D-treated silages, but were increased ($P < 0.05$) in the L treatments. End-point OMD was reduced ($P < 0.05$) in all D treatments at R, whereas no differences ($P > 0.05$) were observed at 40°C for any treatment. It is concluded that Liquicell 2500 shows potential to increase the rate of rumen degradation.

Key Words: Maize silage, Enzymes, Temperature

1762 Evaluation of a novel psychrophilic enzyme mixture as a potential additive for maize silage. D. Colombatto^{*1}, F. L. Mould¹, M. K. Bhat², G. Black³, and E. Owen¹, ¹The University of Reading, UK, ²Institute of Food Research, Norwich, UK, ³University of Sunderland, UK.

The fermentation characteristics and in vitro degradation of maize silages were examined to evaluate the effects of addition of a psychrophilic enzyme mixture at ensiling. The enzyme mixture (E) was a crude extract from the bacterium *Flavobacterium xylanivorum*, and contained mainly xylanase activity. Forage maize (335, 461, 219, 354 g/kg DM, NDF, ADF and starch, respectively) was ensiled in triplicate in minisilos, with or without enzyme addition at two levels (10 and 20 ml/kg forage DM, E1 and E2). The silos were stored at room temperature (15-20°C for 210 days. No effects ($P > 0.05$) on silage pH were observed (4.04, 4.13 and 3.96 for control, E1 and E2). NDF and ADF were numerically increased ($P > 0.05$) by E addition (417, 423 and 448 g/kg; 209, 216 and 240 g/kg of NDF and ADF for control, E1 and E2), whereas starch contents appeared to decrease with the highest level of addition (388 vs. 352 g/kg DM). In vitro gas production and OMD dynamics were assessed using the Reading Pressure Technique. Rumen fluid was collected pre-feeding (0700 h) from a cow fed on a maize silage-based TMR. Gas pressure measurements were taken 14 times over the incubation period, and sets of treatments were removed in triplicate after 6, 12, 19, 24, 48 and 96 h incubation, to determine OMD. No differences ($P > 0.05$) were detected in the rates of gas production, whereas initial OMD (6 h) was increased ($P < 0.05$) with E1 (174 vs. 202 g/kg for control and E1), but decreased ($P < 0.05$) with E2 (174 vs. 162 for control and E2). End-point OMD (96 h) was unaltered by E1 (774 vs. 480 g/kg for control and E1) but decreased ($P > 0.05$) by E2 (774 vs. 750 g/kg). If confirmed in vivo, the observed increased rate of silage OMD treated with this enzyme could lead to an increase in DM intake. However, over-treatment of silages may result in a decrease of the resultant nutritive value.

Key Words: Maize silage, Psychrophilic, Enzyme

1763 Effect of ensiling, storage time and inoculant use on amino acid composition of alfalfa silage preserved in silage bags. S. P. Crosby^{*1}, J. Zmich¹, R. A. Patton², M. J. Stevenson³, and R. T. Ward⁴, ¹Finger Lakes Nutrition, Genoa, NY/USA, ²Nittany Dairy Nutrition, Mifflinburg, PA/USA, ³Degussa-Huls Canada, Burlington, Ont/Canada, ⁴Cumberland Valley Analytical Services, Maudsenville, MD/USA.

Previous work had suggested that during ensiling of alfalfa lysine and arginine were destroyed to a larger degree than other amino acids. To investigate this, fresh alfalfa from two farms in New York state was sampled immediately before storing in silage bags. Ensiling management on these farms was excellent. Corresponding samples were obtained at feed out. A silage inoculant (Biotol Plus II, Biotol Inc) was added at the rate of 120,000 CFU per gram of wet forage. Sampling was based on field, day of cutting and inoculant use. Ten grab samples were mixed and a sub-sample sent to the laboratory for analysis. Nutrient analyses were performed and amino acid content was determined. In all 34 samples (14 inoculated) were analyzed. Effects of fermentation and correlation between wet and ensiled nutrients were evaluated using Proc GLM of SAS with farm and fermentation as factors. Effects of storage time and inoculation were evaluated using Proc Mixed of SAS with fresh values as covariate. Addition of silage inoculant resulted in statistically higher energy (TDN 59.4 vs 60.8, $P < .05$) because of lower fiber values (ADF 35.1 vs 33.3, $P < .02$) but had no effect on protein fractions except for preserving lysine (4.01 vs 4.38, $P < .08$) and arginine (2.08 vs 2.74, $P < .01$). Main effects (ls means) of ensiling on protein fractions is presented below. We conclude amino acid losses under conditions of good ensiling practice appear to be minimal with the exception of arginine.

Nutrient	Fresh	Ensiled	P	% Change
CP	22.2	21.3	.01	-4.05
Available P	20.9	20.0	.01	-4.31
Unavailable P	1.30	1.27	.46	-2.31
NDF-P	2.92	2.27	.03	-22.26
MET % CP	1.27	1.34	.02	5.51
LYS % CP	4.43	4.14	.01	-6.55
LEU % CP	6.15	6.27	.42	1.95
ILE % CP	3.56	3.79	.01	6.46
VAL % CP	4.82	5.09	.01	5.60
THR % CP	3.90	3.64	.01	-6.67
ARG % CP	3.60	2.32	.01	-35.56
HIS % CP	1.73	1.54	.01	-10.98
PHE % CP	4.12	3.80	.01	-7.77
Total AA %DM	16.2	14.8	.01	-8.64
Total Essen %DM	7.7	7.0	.01	-9.09
Total Essen %CP	33.6	31.9	.02	-5.06

Key Words: Haylage, Arginine, Amino acids

1764 Effect of added degradable intake protein on *in situ* and *in vivo* digestibility of processed and unprocessed corn silage fed to beef steers. C.W. Hunt¹, L.R. Kennington^{*1}, G.T. Pritchard¹, J.I. Szasz¹, and W. Mahanna², ¹University of Idaho, Moscow, ²Pioneer Hybrid International, Des Moines, IA.

An experiment with a 2 x 2 factorial arrangement of treatments tested the main effects and interactions of mechanical processing (P+ or P-) of corn silage and DIP level as modified by urea (U+ or U-) on *in situ* and *in vivo* digestion. Treatments were evaluated using four ruminally and duodenally cannulated Angus steers in a 4 x 4 Latin square design. Diets contained 60% corn silage (DM basis) with the remainder being alfalfa hay; 0.5% urea replaced alfalfa in U+ treatments. The level of urea was determined using the 1996 Beef NRC Model to ensure adequate degradable intake protein. Steers were adjusted to silage-based diets for four weeks, then placed on treatment diets for 10-d followed by a 4 d collection period. Chromic oxide was used as an external digestibility marker. Ruminant NH₃ levels were higher ($P < .01$) for U+ than U- diets (13.2 vs. 8.9 mg/dL). Ruminant *in situ* incubations were for 24 and 72 h. No treatment differences ($P > .10$) were observed for OM intake or digestibility. Starch digestibility was greater ($P < .10$) for P+ than P- corn silage (98.6 vs. 96.5%). Urea increased NDF digestibility of P- diets (57.9 vs. 54.6%), but decreased NDF digestibility in P+ diets (53.4 and 56.5%; processing x urea, $P < .05$). Starch degradation *in situ* was greater ($P < .05$) at 24 h for P+ than P- silage (87.4 vs. 66.5%) with no differences ($P > .10$) observed at 72 h. Degradation of NDF was greater ($P < .05$) at 24 and 72 h for P- than P+ corn silage (22.1 vs. 28.4% and 47.8 vs. 50.7%, respectively). The increase in starch degradation in the first 24 h may partially explain the decreased NDF degradation in the P+ silage. Results indicate that improved ruminal starch degradability achieved from mechanical processing is detrimental to NDF degradation, and this effect is not corrected with additional DIP.

Key Words: Corn Silage, Digestibility, Starch

1765 Interactions of corn silage particle size and tallow supplementation on rumen fermentation and performance of dairy cows fed corn silage-based diets. S. G. Onetti^{*}, R. D. Shaver, and R. R. Grummer, *University of Wisconsin-Madison*.

In a previous study (Onetti et al., J. Dairy Sci. 83 (Suppl. 1):277) we showed that including 2% tallow in corn silage-based diets has negative effects on production and rumen fermentation of high producing dairy cows. The objective of this study was to determine if the length of chop of processed corn silage influences the impact of supplemental fat on rumen fermentation and performance of dairy cows. We hypothesized that increasing forage particle length may alleviate the interference of fat on rumen fermentation. Sixteen Holstein cows averaging 120 DIM were used in a replicated 4 x 4 Latin square design with 21d periods. Treatments were arranged in a 2 x 2 factorial design with 0% or 2% tallow (DM basis), and corn silage harvested at either 1.9 cm or 3.2 cm theoretical length of cut. The forage:concentrate ratio was 50:50, and diets were formulated to contain 18% CP and 32% NDF (DM basis). Cows were allowed ad libitum consumption of diets that were fed twice daily as a TMR. Fat supplemented cows had lower DMI and produced less milk fat relative to non-supplemented cows. No effect of silage particle

length was observed for DMI and milk fat production. Milk production tended to be higher for cows consuming short-cut silage without supplemental fat. Rumen pH was not affected by supplemental tallow, and tended to be higher for cows eating long-cut silage. No effect of treatments was observed for rumen ammonia concentration. In this study, tallow supplementation had a negative impact on performance of dairy cows regardless of the corn silage particle length.

Corn silage, cm	0% Tallow		2% Tallow		Significance ($P < .1$) ¹		F _{xL}
	1.9	3.2	1.9	3.2	F	L	
DMI, kg/d	26.7	26.5	25.0	25.0	0.001	NS	NS
Milk, kg/d	42.4	40.7	40.5	40.9	NS	NS	0.11
Fat, %	2.92	3.02	2.71	2.72	0.001	NS	NS
Fat, kg/d	1.23	1.23	1.10	1.10	0.001	NS	NS
pH	6.06	6.15	6.13	6.24	NS	0.09	NS
NH ₃ , mg/dl	14.7	15.2	17.1	14.8	NS	NS	NS

¹F = main effect of fat, L = main effect of length of cut, F_{xL} = interaction

Key Words: Tallow, Corn silage and particle size, Rumen fermentation and milk fat

1766 The effect of ensiling whole plant corn and wet corn gluten feed simultaneously on silage fermentation. J.A. Mills* and R.J. Grant, *University of Nebraska, Lincoln NE.*

The objective of this study was to evaluate the effect of corn silage combined with graded levels of wet corn gluten feed on silage fermentation in laboratory silos. Six combinations were ensiled in triplicate in micro silos for 37 d. Treatments were corn silage with wet corn gluten feed (WCGF) replacing 0, 20, 40, 60, 80, or 100% of the corn silage (DM basis). The treatment containing 0% wet corn gluten feed was designated as the control. Samples were collected before and after ensiling to determine ensiling characteristics and forage quality. The initial pH of control was highest ($P < 0.05$) at 6.02, and decreased with increasing levels of WCGF (3.91 for 100% WCGF). Packing density increased linearly with addition of WCGF (238 to 611kg/m³, DM basis). Prior to ensiling, water-soluble carbohydrate concentrations averaged 9.4% of DM for all treatments. Ammonia-nitrogen concentration increased (0.04, 0.06, 0.06, 0.09, 0.09, and 0.10% of DM) as did crude protein (9.1, 12.6, 12.8, 18.8, 21.1, and 22.5%) with increasing WCGF. The NDF percentage decreased with addition of WCGF (44.2, 39.2, 38.9, 38.1, 36.3, and 37.8% of DM) to corn silage. After ensiling, pH ranged from 3.87 (control) to 4.16 (40% WCGF). Water-soluble carbohydrates utilized during ensiling decreased with increasing amount of WCGF (8.8, 8.6, 8.4, 6.3, 3.2, and 1.9% of DM). Ammonia-nitrogen concentrations were lowest (0.085% of DM, $P < 0.05$) in the control silage; however, ammonia-nitrogen showed the greatest increase when compared with the initial concentration (50%). Dry matter recovery ranged from 86.7 (20% corn silage) to 96.2 (100% WCGF). In vitro NDF digestibility was greatest ($P < 0.05$) at 60% WCGF (60.7%) and lowest at either 100% WCGF (41.2%) or 100% corn silage (44.9%). Addition of wet corn gluten feed to whole plant corn at ensiling had no negative effects on corn silage fermentation and has the potential to be a suitable way to increase packing density in the silo for corn silage.

Key Words: Corn silage, Wet corn gluten feed, Silage quality

1767 Fermentation characteristics of alfalfa hay harvested at different stages of maturity and cutting times in continuous cultures of rumen contents. H. Han*¹, H. S. Hussein¹, J. P. Tanner¹, and H. F. Mayland², ¹University of Nevada-Reno, Reno, NV, ²USDA-ARS, Kimberly, ID.

This study was designed to investigate the ruminal fermentation characteristics of first harvest (1998) alfalfa hay as influenced by the stage of maturity and cutting time. Eight dual-flow continuous culture fermenters were used in an incomplete block design experiment. Nine alfalfa hay substrates were evaluated in four experimental periods (blocks; 8 d each with 5 d for adjustment and 3 d for sample collection) to allow for 3 replications for each treatment. The treatments were arranged as a 3 × 3 factorial. The main factors were 3 stages of maturity (i.e., vegetative, early bud, and 1/10 bloom) and 3 times of cutting (600, 1500, and 2100). The CP content averaged 23.3, 21.6, and 15.5 % (DM basis) for

the vegetative, early bud, and 1/10 bloom stages, respectively. No interactions ($P > .05$) were detected for any of the measurements evaluated. Cutting time did not affect ($P > .05$) OM digestion, N metabolism, or VFA concentrations. The following table summarizes the effects of stage of maturity on ruminal fermentation of the hay. Results suggested that time of cutting alfalfa had no effect ($P > .05$) on ruminal OM fermentation or N metabolism. Despite the highest ruminal degradation of alfalfa CP at the vegetative stage, results indicated greater amounts and higher efficiency of ruminal bacterial protein synthesis at this stage of maturity. Therefore, ruminants may utilize nutrients in alfalfa hay at higher efficiency if it is cut at earlier stages of maturity.

Item	Vegetative	Early bud	1/10 Bloom	SEM
True OM digestibility, %	58.4	57.5	56.4	2.4
N intake, g/d	3.42 ^a	3.21 ^b	2.48 ^c	.004
Effluent bacterial N, g/d	1.70 ^a	1.46 ^{ab}	1.22 ^b	.09
CP degradation, %	92.7 ^a	83.4 ^{ab}	75.3 ^b	3.7
Bacterial synthesis, g N/kg				
OM truly digested	43.3 ^a	37.5 ^b	31.7 ^c	1.3
Effluent NH ₃ -N, mg/100 ml	48.3 ^a	41.0 ^b	24.9 ^c	.7
Total VFA, mM	93.0 ^a	87.4 ^b	81.7 ^c	1.3

Key Words: Continuous culture, Alfalfa hay, Stage of maturity

1768 High oil corn silage versus typical corn silage for cows early in lactation. J. G. Linn¹, D. G. Johnson¹, J. M. Akayezy¹, F. N. Owens*², D. W. Rice², B. L. Smith², and M. A. Hinds², ¹University of Minnesota, St. Paul, MN 55108, ²DuPont Specialty Grains, Des Moines, IA 50322.

To test effects of corn silage source on milk production and composition, 45 cows (24 multiparous and 21 primiparous) were fed one of three diets (46% corn silage) for 112 days starting 3 days after calving. Diets included 1) normal corn silage (C), 2) high oil corn silage (HO), and 3) C with 1.4% tallow added to the diet at feeding time (CT). Yield of dry matter (Mt/ha) was 45.9 for high oil corn silage and 38.1 for typical corn silage; starch was slightly less (18.2 vs 18.6% of DM) but ether extract was greater for the high oil corn silage (4.0 vs 3.1% of DM). Diet ether extract averaged 3.5, 3.9, and 4.8% of DM for C, HO, and CT diets. Dry matter intake was 11.1% greater for the HO diet. Apparent digestibility of most nutrients did not differ significantly between treatment groups, but fat digestibility was increased ($P = 0.10$) by adding tallow to C (77.2 vs 72.9%). Total milk yield and fat corrected milk production were numerically (2.2 and 5.0%), but not statistically, greatest for cows fed the HO diet (36.4, 38.3, and 36.8 kg FCM/d for C, HO, and CT diets). Fat concentration and yield both tended to be higher (3.7 and 6.5%) for cows fed HO; milk protein concentrations and yields were lowest for cows fed C (1.18, 1.23, and 1.23 kg protein/d with C, HO, and CT diets). Persistency of milk production, based on regression of milk production from day 60 to 105, tended to be greater for cows receiving more ether extract (monthly declines of 10.1, 7.3, and 7.4% for C, HO and CT diets). Compared with milkfat from cows fed CT, concentrations of short-chain fatty acids (C6 through C15) were higher in milkfat from cows fed the C and HO diets. Trans- and cis-18:1 levels were higher in milkfat from cows fed CT than for cows fed C. Milk fat produced by cows fed CT had more CLA (0.55, 0.64, and 0.84% CLA for C, HO, and CT diets). Feed intake and milk production persistency tended to be enhanced by substituting high oil corn silage for typical corn silage.

Key Words: High oil corn, Milk production, Milk composition

ASAS/ADSA Growth and Development

1769 Granular-secretory fraction of the bovine fetal cotyledons: I. Elution pattern and electrophoretic characterization. F.G. Rios¹ and F.A. Nuez², ¹FMVZ- Universidad Autonoma de Sinaloa, Culiacan, Sinaloa Mexico., ²FZ-Universidad Autonoma de Chihuahua..

To determine the elution pattern and electrophoretic characterization of granular-secretory fraction of the bovine fetal cotyledons, an experimental procedure was developed. A multi-proteic complex extract of the granular-secretory fraction of the bovine fetal cotyledons, was frozen at -20°C, then was centrifuged at 46,000 x g for 60 min at 4°C. After that, the supernatant was removed and saved by further use. The pellet was washed with a 0.05 M NH₄HCO₃ buffer solution at pH 7.8 and then was centrifuged at 46,000 x g at 4°C for 60 min, the supernatant also was removed. Both supernatants were mixed and suspended together, then recovered protein was quantified reading in spectrophotometer at 595 nm. The suspension was applied to a 5 x 70 cm column of Sphadex G-75. The protein was eluted with a pH 7.8 buffer solution of 0.05M NH₄HCO₃ at 4°C. From the elution peak observed in the elution pattern, aliquots were obtained for electrophoretic characterization. The fractions with MW, were divided in aliquots of 50 mL or less. 0.125g of sacarose were added for each aliquot. Then were frozen at -20 °C and lyophilized at -44 x 10⁻³ mBar. To characterize the electrophoretic pattern, SDS-PAGE with 12.5% gels were used. Protein recuperation of elution the process was 82.9%. The elution pattern showed three different peaks; the first one named peak A, has the 32.7% of the protein in 150 mL of eluent; in a second peak (B) 62% of protein was obtained in 165 mL of buffer; in a third peak (C), 4.8% of protein was obtained in 140 mL of eluent. The strip pattern of electrophoresis, produced three main regions, the first one grouped three proteins with the higher MW ranks from 42 to 95 kDa, and a second one constituted with proteins of intermediate MW (33.5 kDa); and third one grouping three proteins complex with the lower MW ranking from 20.5 to 28.5 kDa. It is concluded that the procedure described is able to produce partially purified placental bovine proteins usable in bioassays and ultrapurification process.

Key Words: Bovine, Placental , Protein Purification

1770 Granular-secretory fraction of the bovine fetal cotyledons: II. Effect on rate of growth of mice. F.G. Rios¹, F.A. Nuez², and R. Barajas¹, ¹FMVZ- Universidad Autonoma de Sinaloa. Culiacan, Sinaloa Mexico, ²FZ-Universidad Autonoma de Chihuahua.

There are many factors in animal tissues that promote animal growth. The mouse is an adequate animal model to carry out exploratory tests of these substances. Our objective was to determine if an extract of a granular-secretory fraction of bovine fetal cotyledons would promote rate of growth of mice. Sixty pre-pubertal 20-day-old mice (Balb/c strain; male and female; BW 11.4 g), were used in a complete randomized experiment. The animals were allocated individually in metabolic crates, with free access to feed and fresh water. After two days adaptation period, mice were divided into five groups (12 mice/group; six males and six females). The groups were randomly assigned to receive a daily intramuscular injection of various proteins. The treatments were: 1) No injection (control); 2) High Molecular Weight (42-95 kDa) placental protein isolate (HMWP); 3) Intermediate Molecular Weight (33.5 kDa) placental protein isolate (IMWP); 4) Low Molecular Weight (20-28.5 kDa) placental protein isolate (LMWP); and 5) Bovine somatotropin (bST). Body weight and feed intake were recorded daily for a 10 d experimental period. Rate of growth was calculated as average daily gain as percentage of final weight. Feed efficiency was calculated as weight gain divided by feed intake. The experiment was analyzed as a complete randomized design, with comparison of means performed by least significant difference. Feed intake, which averaged 4.12 g/d, was not affected (P>0.10) by treatments. The HMWP treatment improved (P<0.01) growth rate 10.6% (4.71 vs 4.26%/day). Feed efficiency was increased (P<0.01) 16.3% by HMWP (0.235 vs. 0.202 g of gain/g of feed). The other treatments had no effect (P>0.10). We conclude that high molecular weight proteins isolated from the granular-secretory fraction of the bovine fetal cotyledons improves growth in mice.

Key Words: Mice, Growth, Placental Proteins

1771 Tibial lesions in broiler chicks after feeding different dietary concentrations of calcium and ammonium chloride. I. B. Toure*, S. Weisbrode, and J. D. Latshaw, *The Ohio State University.*

Different concentrations of dietary calcium and ammonium chloride were used to influence the development of the tibial growth plate. Day-old male broiler chicks in battery pens were fed 1.0, 0.8 or 0.6% Ca and another diet of 1.0% Ca plus 0.5% NH₄Cl. All diets contained 0.47% NPP and 200 ICU of vitamin D per kg. At 10, 17 and 24 days, six chicks were randomly selected from each treatment. They were euthanized, and the left tibia was removed and cleaned of soft tissue. Calipers were used to measure the length of the bone and the diameter at mid-length. The metaphysis of each end was sectioned longitudinally to permit assessing the growth plate. Distance from growth plate to growth plate was recorded. The bones were fixed in 10% formalin, sectioned, and stained with hematoxylin and eosin. Prior to euthanasia at 24 days, blood was collected by heart puncture to provide plasma for blood chemistry profiles. Plasma from the 0.6% Ca chicks was significantly lower in Ca (8.2 mg/dL) than that of the other chicks (10.1 mg/dL). At 17 days, chicks fed 1.0% Ca had normal growth plates, tibial dyschondroplasia-like lesions (TDLL) were present in those fed 1.0% Ca + 0.5% NH₄Cl (6/6), 0.8% Ca chicks had TDLL (4/6), and 0.6% Ca chicks had rickets (3/6) or rickets at the distal end and TDLL at the proximal end (3/6). A marked proliferation of osteoprogenitor cells with the formation of spicules and congested vascular channels was noted in birds with the 1.0% Ca + 0.5% NH₄Cl treatment and was the predominant distinctive feature between lesions from that treatment and the 0.8% Ca treatment. We have hypothesized that the marked cellular proliferation could be due to bone morphogenic proteins that are released from bones under the influence of NH₄Cl induced acidosis.

Key Words: Calcium, Growth plate, Tibial dyschondroplasia

1772 Relationships between a single-point mutation in the chloride channel-1 gene and phenotypic responses in the Myotonic goat. B. L. Sayre*, S. Wildeus, M. P. L. Dismann, and J. R. Collins, *Virginia State University, Petersburg, VA.*

The Myotonic goat has congenital myotonia, a mutation in the chloride channel-1 (ClC-1) gene, often associated with muscle hypertrophy. This experiment determined relationships between the presence of a ClC-1 mutation and expression of myotonia in a herd of Myotonic goats. Myotonic does (n=63) were genotyped and phenotyped for presence of congenital myotonia. Spanish does (n=18) were used as negative controls. DNA was harvested from whole blood samples. A 177-bp ClC-1 fragment was amplified with PCR, and then digested with Mbo II. The presence of two (105 & 72 bp), three (72, 53, & 52 bp), or four (105, 72, 53, & 52 bp) fragments was used for classification of genotype as homozygous normal (NORM), homozygous mutated (MYO), or heterozygous (HET), respectively. Phenotype was determined as (1) the duration of muscle knots after a sharp strike with a percussion hammer (five repetitions; PH), (2) duration of myotonia (MD), and (3) severity of myotonia (Scored on a scale of 1-9; MS). After a 20 min rest, does had to jump over a step (approx. 45 cm), which induced myotonia in positive does for measurement of MD and MS. There was a positive correlation between genotype and phenotype (P<.001), and phenotypic measures were positively correlated to each other (P<.001). There were no differences (P>.1) in phenotypic measures between NORM and HET genotypes. MYO had greater (P<.001) MD (5.5 vs. 0.0 sec), MS (5.4 vs 1.0), and PH (4.0 vs.1.1 sec) than NORM and HET. Older MYO does (>2 yrs) had increased (P<.01) MD (6.8 vs. .9 sec), MS (6.6 vs. 1.8), and PH (4.8 vs. 1.5 sec) compared to younger does (<2 yrs). Myotonic goats homozygous for a mutated ClC-1 gene exhibited classic phenotypic responses for congenital myotonia, while heterozygous goats did not show signs of myotonia. In goats homozygous for the mutation, the phenotypic response is less apparent in younger animals than older animals. Future studies will link carcass characteristics to the genotype and phenotype relationships.

Key Words: Myotonic goat, Myotonia, Chloride Channel-1

1773 Effect of Somatostatin-14 (SS-14) and Passive Immunization Against SS-14 on Circulating Levels of Growth Hormone (GH) in Rainbow Trout (*Oncorhynchus mykiss*). B. C. Peterson*, P. R. Simpson, R. W. Hardy, T. L. Ott, A. Ahmadzadeh, and G. T. Schelling, ¹University of Idaho, Moscow, ID/USA.

Previous work indicated that rainbow trout (and other fish) exhibit a tremendous growth response when administered exogenous GH. However, regulation of growth hormone secretion in fish is not well characterized. The objectives of this study were to further examine endogenous GH secretion by determining (1) circulating concentrations of GH in resting fish, (2) the effect of SS-14 on GH release, and (3) the effect of passive immunization against SS-14 on GH release in rainbow trout. In the first study, 10 fish (665 g) were bled from the caudal vessel every 20 min for 4 h to assess the pattern of GH release. Any value of GH greater than 2 SD above the mean, followed by at least 2 values of lesser concentration, was considered a pulse. No pulses were detected in any of the 10 fish and serum GH averaged 4.0 ± 2.6 ng/ml. In the second study, 10 fish (550 g) were used to assess the effect of administration of SS-14 on GH release. Fish received an i.p. injection of 5 ng/g BW of SS-14 or saline. Serial blood samples were taken for 4 h starting 20 min pre-treatment. Results of the study indicated SS-14 decreased ($P = 0.09$) GH levels (1.9 ± 1.7 ng/ml vs 6.4 ± 1.5 ng/ml) compared to control fish. In the third study, 20 fish (450 g) were used to assess the effects of passive immunization against SS-14 on GH release. Fish were selected randomly to receive an i.p. injection of SS-14 anti-serum diluted 1:25 in saline or control serum diluted 1:25 in saline. Fish passively immunized against SS-14 increased ($P < 0.01$) GH levels (12.9 ± 1.0 ng/ml vs 4.9 ± 1.1 ng/ml) when compared to control fish. These results indicate GH in rainbow trout is released in an asynchronous fashion with no evidence of pulsatility and the hypothalamic hormone SS-14 apparently regulates GH secretion similarly in rainbow trout as it does in mammals. Elevation of GH by immunizing against SS-14 may provide another approach of increasing growth rates in rainbow trout.

Key Words: Somatostatin-14, GH, Rainbow Trout

1774 WITHDRAWN , .

1775 Growth and carcass quality of offspring in response to somatotropin (pST) treatment of sows during early gestation. G. Kuhn, C. Rehfeldt*, G. Nrnberg, and K. Ender, *Research Institute for the Biology of Farm Animals, Dummerstorf, Germany.*

The objective of this study (two experiments) was to investigate the influence of pST treatment of pregnant sows on live weight development, compositional characteristics, and meat quality of their offspring. Sixteen sows received daily i.m. injections of 6 mg pST from d 10 to 27 after artificial insemination (pST). Sixteen sows received a placebo (control). Three neonates of the highest (HW), middle (MW), and lowest (LW) birth weights were selected from each litter for dissection into body tissues followed by chemical analysis. The remaining piglets were allocated to the three birth weight classes (HW, MW, and LW) by the help of frequency distribution and reared up to 182 days of age. After slaughter, carcass composition and meat quality of the pigs were examined. All data were statistically analyzed using the mixed model of analysis of variance. The average birth weight of the piglets from treated sows was lower ($P = 0.11$) compared with control piglets with HW neonates being most different ($P = 0.01$). Treatment of sows with pST influenced the body composition of the newborn piglets by increasing the percentages of internal organs ($P = 0.01$) and skin ($P = 0.02$). No differences in protein and lipid content of the piglet body were apparent between the two groups. Postnatal daily gains during various growth phases were not significantly affected, although live weights were lower until d 49 of age due to pST treatment ($P < 0.05$). At slaughter, the percentage of internal organs (empty body basis) was higher in the offspring of treated sows than in corresponding controls ($P < 0.05$). In longissimus muscle, drip loss and intramuscular lipid content were increased due to pST ($P < 0.05$). Moreover, the pH₄₅-value and the brightness of longissimus muscle tended to be affected by pST treatment ($P = 0.08$) to an undesired direction. In conclusion, pST treatment of sows during

early pregnancy was not of advantage for postnatal growth and carcass quality in the offspring.

Key Words: Somatotropin, Pig, Growth

1776 Effect of oxytocin (OT) on hourly milk secretion in gilts with mastitis. R. S. Kensinger*, D. M. Sanzotti, A. L. Magliaro, A. C. W. Kauf, and L. C. Griel, Jr., *Penn State University.*

The objective of the study was to determine if OT treatment (20 IU given IM) on d 3, 5 and 7 of lactation would increase hourly milk yield (HMY) in gilts with intramammary inflammation. The goal is to improve baby pig performance. Gilts (176.4 kg BW; n = 15 in 5 groups of 3) farrowed, and pigs were cross-fostered to equalize litter size to 9.4. The experimental model was lactating Yorkshire crossbred gilts infused with 3.0 ug endotoxin/kg BW into 2 mammary glands at 0715 on each experimental day. The design was a 3X3 Latin Square Design. Litters were separated from dams between hourly weigh-suckle-weigh measurements (from 0800–1700) in order to assess HMY. Gilts were assigned to receive 0, 3, or 5 OT injections (0X, 3X, or 5X) at 0, 4, or 2 h intervals, respectively. Data were analyzed using the GLM option of SAS according to a mixed model design. Rectal temperature (RT) averaged 39.7 C at 0700, increased to 40.8 C at 1200 ($P < .01$), and returned to 39.9 C at 1700 h. Gilts on 3X and 5X had significantly increased RT compared to 0X ($P < .01$). Mean HMY was 100.7, 111.4 and 124.3 g on d 3, 5 and 7 of lactation, respectively ($P < .02$). Mean HMY by 0X gilts was 112.3 g. Mean HMY by 3X and 5X gilts averaged 80.9 g during nursings with no OT injection, and 160.1 g for nursings with OT treatment ($P < .01$). Response to OT treatment attenuated over time in the 5X group, as HMY averaged 173.5 g with first two injections, 137.6 g at third injection, but only 108.9 g at last two injections. The 3X group averaged 150.6, 233.6 and 182.5 g at 0800, 1200 and 1600, respectively. A treatment by time interaction was detected ($P < .01$). Mean HMY (for all nursings) for 0X, 3X and 5X treatment groups averaged 112.3, 117.6 and 106.5 g, respectively ($P > .10$); and there was no difference in 24-h litter weight gains. Results show OT injections improve milk yield at that nursing; but suggest that stress of injections may interfere with response. Data indicate a need for better methods of OT delivery.

Key Words: Porcine lactation, Oxytocin, Endotoxin

1777 Influence of long-term maternal nutrition on ovine fetal growth and development. SP Quigley*¹, DO Kleemann¹, SK Walker¹, JA Owens², PI Hynd², G Natrass¹, SR Barritt¹, and PA Speck¹, ¹South Australian Research and Development Institute, South Australia, ²University of Adelaide, South Australia.

Genetic and environmental factors during the pre-natal period affect the growth of the fetus and may set the potential for postnatal growth. The objective of this experiment was to investigate the effect of long-term nutritional manipulation of the pre-natal environment on fetal growth and muscle development in sheep. Mature age Merino ewes (n=119) were stratified on liveweight and randomly allocated to 2 nutritional treatments of 1.8 and 0.6 times maintenance requirements (High (H) n=60 and Low (L) n=59, respectively). Ewes were fed a pelleted diet (60% roughage: 40% grain plus additives) for 12 weeks prior to, and throughout pregnancy. Pregnant ewes from each treatment group were stratified on litter size, determined by ultrasonography on day 44, and liveweight and were randomly allocated to one of three sample points (day 50, 92 and 133 of gestation). Ewes were euthanased and the fetuses recovered, weighed and dissected and internal organ weights recorded. Samples of internal organs and longissimus dorsi, semitendinosus and supraspinatus muscles, were taken for gene expression analysis. H ewes were significantly heavier than L ewes ($p < 0.01$) at slaughter on day 50 (73.9±2.1 vs 54.8±2.3kg), day 92 (80.1±1.8 vs 57±3.4kg) and day 133 (86.1±2.5 vs 59.3±3.6kg) respectively. Nutrition had no significant effect on fetal weight and organ development during the first 50 and 92 days of pregnancy ($p=0.44$ and $p=0.26$ respectively). By day 133 fetal weight was significantly different between H (4.08±0.11kg) and L (3.57±0.15kg) fetuses ($p < 0.01$). Singleton fetuses were heavier (4.20±0.11kg) than twins (3.57±0.14kg) ($p < 0.01$), while males (4.0±0.13kg) tended to be heavier than females (3.78±0.11kg) ($p=0.18$). However, there were no significant interactions between level of nutrition, litter size and sex. Liver, lungs and kidneys were heavier in day 133 H than L fetuses ($p < 0.05$), while heart weight did not differ between treatments. These results indicate that the effect of nutrition, prior to and during gestation, on ovine

fetal growth and development are not evident until the last trimester of pregnancy. However, the interaction between pre-natal nutrition and the expression of specific genes and implications for postnatal growth are yet to be determined.

Key Words: Sheep, Maternal nutrition, Fetal growth

1778 Stereoselectivity of porcine beta-adrenergic receptors for ractopamine isomers. J.D. Kissel*¹, D.J. Smith², and S.E. Mills¹, ¹Purdue University, ²USDA-ARS Fargo, ND.

Ractopamine is a β -adrenergic receptor (β AR) ligand that enhances protein gain in animals. The commercial product is a mixture of four stereoisomers. In rats, the levorotatory RR isomer seemed to be responsible for the growth response of ractopamine, consistent with known requirements for biological AR-ligand activation. In order to determine the AR stereoselectivity for ractopamine stereoisomers, binding affinities and adenyl cyclase (AC) activation were determined using cloned porcine β 1- and β 2-AR. Chinese hamster ovary cells stably expressing the porcine β 1AR or β 2AR were grown to confluence and cell membranes collected by centrifugation from lysed cells. Dissociation constants (Kd) were determined by competitive displacement of [¹²⁵I]iodocyanopindolol binding by ractopamine isomers, and binding parameters were determined by non-linear regression. Membrane preparations were also used to quantify activation of AC; cAMP was measured by RIA after 10-min incubations with membranes and test ligands. Activation rates were expressed relative to isoproterenol. Experiments were replicated 3 to 5 times. The RR isomer had a high affinity for both β 1- and β 2AR (Kd of 25 and 29 nM, respectively); Kd estimates for the other stereoisomers were higher (RS = 463 and 78 nM, SR = 3,230 and 831 nM, SS = 16,600 and 3,530 nM for the β 1- and β 2-AR, respectively). Isoproterenol stimulated AC activity 600% relative to basal rates with both β AR subtypes. Ractopamine stereoisomers did not significantly stimulate AC through the β 1AR at moderate (near Kd) or high (10^{-4} M) concentrations. In contrast, the RR isomer increased AC activity 200 to 300% through the β 2AR at moderate and high concentrations; RS and SR isomers elicited a 50 to 75% increase in AC, but the SS isomer was ineffective at the β 2AR. The porcine β AR exhibited stereoselectivity towards ractopamine stereoisomers with the RR isomer exhibiting the highest affinity for β 1- and β 2-AR. In contrast, ractopamine stereoisomers seemed to be more effective at eliciting cAMP responses from β 2AR than β 1AR.

Key Words: Pig, Receptor, Adrenergic

1779 Leptin in neonatal pigs: effects of oral versus intramuscular administration. N.C. Whitley¹, E.L. McFadin-Buff*², P.R. Buff², and D.H. Keisler², ¹University of Maryland-Eastern Shore, Princess Anne, MD, ²University of Maryland, Columbia, MO.

Leptin is found in milk and has been implicated in growth and development of neonates. Milk leptin levels are greatest during the first hours after parturition, then decline and remain low throughout the remainder of lactation. This observation indicates that leptin may influence the neonate if leptin absorption occurs with oral consumption of leptin. The objective of this study was to compare peripheral serum concentrations of leptin in neonatal pigs after oral or intramuscular administration leptin. Thirty-three pigs from 6 sows were used. Between 5 and 20 hours after birth, pigs were weighed, numbered, and treated with either a single intramuscular injection of sterile saline (C), or 2.5 mg/g BW ovine leptin, administered either orally (O) or intramuscularly (I). Pigs from each treatment were chosen for sacrifice at 2, 4, 6, or 8 h after treatment. At euthanasia, blood samples were collected for analysis of serum leptin levels. Liver tissue samples were collected and total liver RNA was used for determination of leptin receptor mRNA expression using porcine 28S and leptin receptor probes in a slot blot technique. There was no effect of time after treatment on either variable. Both oral ($P < .07$; tendency) and injected ($P < .001$) leptin increased serum concentrations of leptin over that of control pigs, with injection producing the highest serum leptin concentrations ($P < .001$). Serum leptin averaged 6.2 ± 4.9 , 19.5 ± 4.5 and 101.7 ± 5.4 ng/ml for controls, O and I pigs, respectively. Leptin receptor mRNA (leptin receptor mRNA:28S mRNA) was not influenced by treatment and averaged 7.7 ± 2.2 , 5.5 ± 2.1 and 6.3 ± 2.2 relative optical density units for C, O, and I treatments, respectively. Milk samples taken from sows soon after parturition were also analyzed for leptin and averaged 98.9 ng/ml. It is concluded that oral administration of leptin can be absorbed to influence peripheral leptin levels.

Leptin levels are highest in the milk of sheep and swine during the first 24 hours after parturition, and this study supports the hypothesis that leptin may play a role in the fetal to neonatal transition process.

Key Words: Leptin , pig, milk

1780 Endocrine response and fat metabolism change in finishing pigs treated with N-methyl-D,L-aspartate(NMA). Gang Xi*, Zirong Xu², and Ping Xiao², ¹University of Minnesota, St. Paul, MN, ²Zhejiang University, Hangzhou, China.

A trial was conducted to investigate the effect of the additional of NMA in diet on several growth related hormones and fat metabolism in finishing pigs. A total of 84 cross bred finishing pigs (average initial BW of 56 ± 0.37 kg) were divided into 6 pens, 14 pigs per pen (7 gilts and 7 barrows per pen). 3 pens of pigs were fed with control diet (corn-soybean meal) and the others were fed control diet addition with 50 mg/kg NMA. During trial, all pigs were given free access to feed and water. After 44 days trial, 8 pigs from each treatment (4 gilts and 4 barrows, weight similar to average group weight, 86.94 ± 0.71 kg for control group, 90.55 ± 1.51 kg for NMA treated group) were sacrificed to collect the sample of liver, longissimus muscle, subcutaneous fat (10th rib), and hypothalamus. Before the pigs were slaughtered, blood samples were collected and allowed to clot overnight at 4 °C. Serum was then harvested after centrifugation and stored at -20 °C until assayed. The addition of NMA in diet increased the IGF-I, Insulin, T₃, T₄ and TSH levels in serum with 50.68% ($p < .05$), 62.61% ($p < .02$), 123.33% ($p < .01$), 60.58% ($p < .03$) and 78.40% ($p < .02$), respectively. Meanwhile, cAMP level and IGF-I level in the liver were increased with 26.93% ($p < .01$) and 26% ($p < .03$) with addition of NMA. In contrast, cAMP level in the hypothalamus was decreased 21.89% ($p < .01$). The data from subcutaneous fat (10th rib) analysis showed that supplement of 50 mg/kg NMA decreased the total activities of malic dehydrogenase (MDH) by 20.54% ($p < .04$), glucose-6-phosphate dehydrogenase (G-6-DPH) by 16.97% ($p < .04$), and decreased the specific activities of MDH and G-6-DPH by 37.46% ($p < .001$) and 35.06% ($p < .01$), respectively. The hormone sensitive lipase (HSL) total activity was increased by 25.00% ($p < .02$) in NMA treated pigs. These results indicated that adding of 50 mg/kg NMA to diet can induce the endocrine dramatic change in finishing pigs, further, inhibit the fat synthesis through suppressing fat synthetases and promote the fat degradation by elevating HSL activity in finishing pigs.

Key Words: Endocrine Response, Fat Metabolism, NMA

1781 Studies on lipid metabolism in hepatocytes from growing pigs. T.J. Caperna*¹, I. Fernandez-Figares¹, A.E. Shannon¹, and D. Wray-Cahen², ¹USDA, ARS, Beltsville, MD, ²FDA, Rockville, MD.

Two *in vitro* assay systems were developed to elucidate the role of leptin in lipid oxidation (OX) and ketogenesis in pig liver. Glucagon (G): insulin (I) ratios of media were manipulated, to investigate interactions of leptin with I and G in hepatocyte monolayers. Hepatocytes were isolated from 30-70kg barrows and seeded into pig tail collagen-coated T25 flasks. Monolayers were established in medium containing fetal calf serum and switched after 24h to serum-free media containing dexamethasone (10^{-6} M) and 1% DMSO. To evaluate palmitate OX, a culture medium was formulated to maintain hepatocytes in an air environment (2:1 mixture of M199/HBSS and M199/EBSS containing 25mM HEPES). Cells were maintained in media containing 50ng/ml I, with G levels increasing from 20 to 500ng/ml. On day four, medium containing 0.23mM $1\text{-}^{13}\text{C}$ -palmitate was added to flasks and 6h gas samples were collected for determination of $^{13}\text{CO}_2$ by IRMS. As the ratio of G:I decreased from 10:1 to 0.4:1, palmitate OX increased by 13.5% ($P < 0.02$, $n=4$); chronic rh-leptin exposure (200ng/ml, 2.5d) had no apparent effect on palmitate OX under these conditions. For determination of ketogenesis, cells were maintained in DMEM/M199 containing both I and G between 1 and 100ng/ml with or without rh-leptin. Medium was collected on the fourth day, following a 24h incubation period and β -hydroxybutyrate (BHB) and acetoacetate (ACAC) were determined fluorometrically using a BHB-dehydrogenase-NADH coupled system. Ketone production was stimulated by G and inhibited by I; depending on the G:I ratio (0.01:1 to 100:1), total ketone production ranged between 100 and 400nmol/mg protein/24h. Addition of rh-leptin had no consistent effect on ketone production or BHB:ACAC ratio (0.98 control, 0.97 rh-leptin). These data suggest that while pig hepatocytes are indeed

sensitive to hormonal manipulation, chronic exposure to rh-leptin did not directly influence lipid OX and metabolism. Supported in part by a Spanish Ministry of Education fellowship (IF-F).

Key Words: Ketogenesis, Lipid oxidation, Leptin

1782 Recruitment and differentiation of intramuscular preadipocytes in stromal-vascular (S-V) cell cultures derived from fetal pig semitendinosus muscles. G.J. Hausman, R. Gaines, and S.P. Poulos, *USDA ARS, Athens, GA*.

Semitendinosus muscles in 105 day old fetuses contain a small number of intramuscular adipocytes. Therefore, we examined intramuscular preadipocyte development in S-V cell cultures derived from semitendinosus muscles from 105 day old fetuses. Both semitendinosus muscles were excised from 4-8 fetuses removed from each of four dams laparotomized at 105 days of gestation. All visible connective tissue was removed from the muscles prior to mincing and processing with a conventional collagenase digestion used to establish adipose tissue S-V cell cultures. Four muscle S-V cell cultures were established since muscles were pooled for each litter. After 1 hour in 10% fetal bovine serum (FBS) one-half of the muscle S-V cell cultures were rinsed to remove debris and insoluble muscle protein. Cultures were reacted for the AD-3 antibody, a preadipocyte marker, or stained for lipid. Preadipocytes (AD-3+) were randomly distributed and not clustered after 1 day in FBS. After 4-5 days in 10% FBS muscle S-V cell cultures reached confluence with large clusters of preadipocytes. Treatment with insulin + dexamethasone (DEX) for 5 days after confluence did not increase preadipocyte number ($P > .05$), but markedly increased preadipocyte size with no consistent change in lipid accretion. The proportion of large preadipocyte clusters (> 3 cells) was similar before and after DEX + insulin treatment ($75 \pm 12\%$ and $75 \pm 9\%$; respectively) but was reduced ($P < .05$) to $46 \pm 6\%$ in cultures treated with insulin alone. Muscle S-V cell cultures seeded on laminin coated dishes contained only preadipocytes whereas laminin coated dishes contained preadipocytes and earlier precursor cells in previous studies of adipose tissue S-V cell cultures. Thus, preadipocyte precursor cells are not present in fetal muscle.

Key Words: preadipocytes, pig muscle, differentiation

1783 The effect of LXR α ligands on adipocyte differentiation. T.D. Brandebourg* and C.Y. Hu, *Oregon State University, Corvallis*.

We recently demonstrated that ligand activation of LXR α , an orphan receptor expressed in adipose tissue, negatively regulated adipocyte differentiation. Administration of an LXR α agonist inhibited differentiation of 3T3-L1 cells while geranylgeraniol (GG), a metabolite of mevalonic acid that antagonizes LXR α , blunted the inhibitory effect of the LXR α agonist. The objective of this study was to extend those results by evaluating the effect of several LXR α ligands [22(R)-hydroxycholesterol (22R), 22(S)-hydroxycholesterol (22S), 20(S)-hydroxycholesterol (20S), 25-hydroxycholesterol (25OH),] on the differentiation of 3T3-L1 preadipocytes. Cells were grown to confluence (d -2) and differentiation was induced on d 0. Cells were treated with either ligand or carrier (ETOH) from d 0 to d 7. In separate experiments, either individual LXR α ligands or cholesterol (Chol), which neither activates nor binds LXR α , were administered at concentrations of 2.5, 5, 10, or 20 mM. Differentiation was evaluated by measuring sn-glycerol-3-phosphate dehydrogenase (GPDH; EC 1.1.1.8) activity on d 8. Independent experiments were performed on duplicate wells where $n=4$ for 22R, 20S, 25OH and Chol and $n=2$ for 22S. 25OH significantly decreased GPDH activity (nmol/(min*mg protein) versus controls by 42% at 2.5 mM ($p < .001$), 53% at 5 mM ($p < .01$), 61% at 10 mM ($p < .001$) and 66% at 20 mM ($p < .001$). Administration of 22R decreased GPDH activity by 9% at 2.5 mM ($p < .05$), 17% at 5 mM ($p < .001$), 35% at 10 mM ($p < .001$) and 41% at 20 mM. Administration of 20S decreased GPDH activity by 12% at 2.5 mM ($p < .001$), 20% at 5 mM ($p < .01$), 27% at 10 mM ($p < .01$) and 57% at 20 mM ($p < .001$). Conversely, administration of 22S, which is known to bind LXR α with high affinity, failed to significantly alter GPDH activity at any concentration. As expected, Chol did not affect GPDH activity at any concentration tested. These results further support a role for LXR α in the regulation of adipocyte differentiation. 25OH was most efficacious while 22R and 20S decreased GPDH activity with similar efficacies. Importantly, 22S represents a

potential LXR α antagonist that may prove useful in subsequent studies of the role of LXR α as a regulator of adipocyte differentiation.

Key Words: Adipose Tissue, Differentiation, LXR

1784 Hormonal regulation of postnatal chicken preadipocyte differentiation in vitro. T. G. Ramsay* and R. W. Rosebrough, *USDA-ARS, Beltsville, MD*.

The present study was designed to develop a chronic culture system from the stromal vascular fraction of chicken adipose tissue for use in identifying hormones or peptides that promote adipocyte formation. Abdominal adipose tissue was excised from 2-4 week old male broilers by sterile dissection. The stromal vascular cell fraction from the adipose tissue was isolated by collagenase digestion, filtration, and subsequent centrifugation. These preadipocytes were seeded in six well culture plates and proliferated to confluency in 10% fetal bovine serum in DMEM/F12 (50:50) medium. At confluency, experiments were initiated to determine hormonal requirements for differentiation in the presence of 2.5% or 10% chicken serum. Isobutylmethylxanthine (10 mM) in combination with 1 μ M dexamethasone could not promote differentiation, as determined by the expression of citrate lyase (CL) and sn-glycerol-3-phosphate dehydrogenase (GPDH) relative to lactate dehydrogenase. Insulin (100 nM) stimulated expression of CL and GPDH ($P < 0.05$) in the presence of 2.5% chicken serum, but not with 10% chicken serum. Triiodothyronine (1 nM) and IGF-I (100 ng/ml) had no effect on differentiation. Dexamethasone (1 μ M) stimulated differentiation in 2.5% or 10% chicken serum ($P < 0.05$). The combination of insulin and triiodothyronine stimulated differentiation ($P < 0.05$) but the effect was no greater than insulin alone in medium containing 2.5% chicken serum. Insulin, dexamethasone and 2.5% chicken serum synergistically stimulated differentiation and can replace 10% chicken serum in culture. Development of a culture system that only requires low serum concentrations for stimulating adipocyte formation may permit identification of important regulatory hormones for differentiation.

Key Words: Preadipocyte, Differentiation, Chicken

1785 Effects of dietary protein on the endogenous calpain/calpastatin proteolytic system in canine skeletal muscle. E. E. Helman*¹, E. H. Lonergan¹, S. M. Lonergan¹, and G. M. Davenport², ¹*Iowa State University, Ames, IA*, ²*The Iams Company, Lewisburg, OH*.

The cysteine proteinases μ - and m-calpain along with their inhibitor, calpastatin, and possibly skeletal muscle specific p94, have been hypothesized to play a role in skeletal muscle protein degradation. Previous studies have indicated a nutritional influence on calpastatin. Our working hypothesis is that protein nutrition can influence regulation of the calpain system in muscle. Our objectives were to determine the effects of dietary protein on the expression of calpastatin and p94 in canine skeletal muscle. A biopsy was taken from the semitendinosus of 56 dogs prior to and after 12 weeks on their respective diets. This experimental design allowed us to examine change within individual dogs. Our study consisted of 8 diets with 7 dogs per diet. Diets 1-4 were 12% total protein and contained ratios of chicken to corn gluten protein of 100:0, 67:33, 33:67, and 0:100%, respectively. Diets 5-8 were 28% total protein with identical protein ratios to diets 1-4. We examined these differences qualitatively using SDS-PAGE and immunoblotting, and quantitatively with densitometric analyses. Western blots were completed using an anti-calpastatin antibody (MA3945, Affinity Bioreagents). p94 blots were examined with an anti-p94 antibody (NCL-CALP-12A2, Novocastrol Labs). The majority of our calpastatin blots showed an expression of three distinct calpastatin bands, the uppermost appearing at approximately 110 kDa. Diet 5 resulted in an increase in the expression of the 110 kDa calpastatin band. A significant difference ($P < 0.05$) was obtained from comparison of the ratio of relative intensity in all three bands when comparing diet 5 (100:0) to diet 8 (0:100). Our results showed no treatment differences in detection of p94. Our calpastatin data suggest that dogs fed a diet containing a higher percentage of chicken protein may have a greater potential to regulate calpain-mediated degradation of muscle protein.

Key Words: p94, calpastatin, canine

1786 Growth of myoblasts derived from genetically different mice, pigs, and cattle. C. Rehfeldt^{*1}, G. Nürnberg¹, U.K. Zettl², E. Mix², M. Wittstock², U. Renne¹, H.J. Papstein¹, and K. Ender¹, ¹Research Institute for the Biology of Farm Animals, Dummerstorf, Germany, ²Rostock University, Rostock, Germany.

The objective of this study was to investigate the influence of long-term selection for different growth traits on intrinsic differences in myoblast proliferation activity and susceptibility to serum deprivation. Myoblasts were isolated from three lines of mice selected for more than 70 generations for 6-weeks body weight (DU-6), protein content (DU-6P), or an index from body weight and physical endurance fitness (DU-6+LB), and from a control line (DU-Ks); from wild-type (WP) or German Landrace domestic pigs (DP); and from Holstein Friesian (HF) or White Blue Belgium (WBB) cattle. During ten days of cultivation in DMEM with 8% FBS the cells of each selected mouse line accumulated more DNA and protein as compared to the control line ($P < 0.01$) with DU-6+LB > DU-6 > DU-6P ($P < 0.05$). Porcine myoblasts from *Semiteminosus* muscle of neonatal WP or DP were grown for six days in MEM α with 10% FBS. The cells from the highly selected DP accumulated less DNA than WP cells (1.06 vs 1.71 g/well, $P < 0.0001$). There were only small differences in the growth kinetics between HF and WBB myoblasts from *Biceps brachii* muscle of three month old fetuses grown for six days in DMEM with 10% FBS. The WBB myoblasts synthesized more protein than HF myoblasts from d 4 to 6 of cultivation (17 to 30%, $P < 0.0001$) whereas DNA levels did not clearly differ. Serum deprivation by changing to 1% FBS during exponential growth as examined in the murine cell lines caused significant decreases in DNA and protein levels ($P < 0.01$) with responses being higher in all long-term selected lines. In part, this was due to apoptosis as examined with DU-Ks and DU-6 cells. Higher percentages of apoptotic cells were found in cultures of DU-Ks ($P < 0.01$) and DU-6 ($P < 0.001$) cells cultivated in 1% as compared with 10% FBS. The results suggest that long-term growth selection is capable to induce intrinsic changes in myoblasts that determine muscle growth.

Key Words: Growth, Myoblast, Selection

1787 Solubilization and purification of a recombinant chicken myostatin expressed as inclusion bodies in *E. coli*. Y. S. Kim^{*1}, K. S. Baek², and M. A. Dunn¹, ¹University of Hawaii, Honolulu, HI, ²National Livestock Research Institute, Namwon, Korea.

The objective of this study was to solubilize and purify a recombinant chicken myostatin fragment expressed as inclusion bodies in *E. coli* culture. Plasmids containing a 369 bp C-terminal fragment of chicken myostatin were transformed into expression competent *E. coli*, followed by IPTG-induced protein expression. Inclusion bodies from the cells were isolated and washed to homogeneity. An average of 80 mg of inclusion body proteins was produced per L of culture. The myostatin inclusion bodies were solubilized in 50 mM Tris buffer containing 8 M urea, 5 mM EDTA, and 200 mM mercaptoethanol. The effect of buffer pH (8, 9, 10, and 11) and incubation condition (30 min boiling and overnight incubation at 25°C with mild shaking) on inclusion body solubilization and purification was investigated using a combination of centrifugation, gel filtration, and SDS-PAGE. When the extent of solubilization was examined by the formation of precipitates after centrifugation at 11,000 g for 10 min, all the above conditions solubilized inclusion bodies at 3 mg/mL. Significant breakdown of recombinant myostatin was observed during the solubilization at pH 10 and 11 in both incubation conditions, but not at pH 8 and 9. A significant proportion of recombinant myostatin stayed as heterogeneous multimer forms in the solubilized inclusion bodies, and increasing pH favored monomer formation. Thus, 30 min boiling or 25°C overnight incubation at pH 9 provided the optimum condition for inclusion body solubilization, and the proportion of monomer was approximately 50% in these conditions. Solubilized inclusion body proteins were refolded using a slow dialysis process by stepwise addition of Tris buffer containing no urea or mercaptoethanol. When the dialyzed inclusion body solutions were subjected to gel filtration, the myostatin monomer fraction was less than 1% of the total protein. This result demonstrates that heterogenous multimer formation had occurred during the dialysis process. Also, it was demonstrated that buffer pH and incubation conditions are important factors affecting solubilization of inclusion bodies.

Key Words: Myostatin, Inclusion body, Purification

1788 Stair-step compensatory growth regimen in dairy heifers and its effects on transition health. M.S. Laubach^{*1}, D.E. Schimek¹, D.B. Carlson¹, A.M. Encinias¹, J.L. Burton², J.W. Schroeder¹, W.L. Keller¹, and C.S. Park¹, ¹North Dakota State University, ²Michigan State University.

The objective of this study was to determine if a one stair-step gestational nutrition regime affects metabolic status and lactation potential of dairy heifers during the transition period. Nineteen Holstein heifers averaging 511 kg of body weight were randomly divided into two treatments. The treatments were imposed at 95 d of gestation. The control group (CON) was fed a diet containing 14% crude protein and 22.5 Mcal of metabolizable energy (ME) per d for the entire 180 d of the trial. The treatment group (TRT) was fed a diet containing 18.5% crude protein and 14.5 Mcal of ME per d until d 185 of gestation, then the diet was changed to 14% crude protein and 29.2 Mcal of ME per d for the realimentation period. Heifers were weighed for three consecutive d at the start, at 185 d of gestation and after calving. Body weights were not different at 185 d of gestation ($P = 0.3$), or at calving ($P = 0.71$). Blood was drawn from the heifers around parturition on d -13, -10, -7, -5, -3, -2, -1, 0 (within 3 hours of calving), 0.5, 1, 2, 3, 5, 7, 10, 13 to monitor various metabolites, white blood cell counts, and lymphocyte populations (CD3, CD4, CD8, and gamma/delta T-cells). Blood glucose levels before calving were higher in the TRT group ($P = 0.08$), but were not affected after calving. Insulin levels were increased in the TRT group before calving ($P = 0.03$), but they were not statistically different after calving. Triglycerides were increased before calving and after calving in the TRT group (before $P = 0.06$, after $P = 0.01$). There were no differences in non-esterified fatty acid concentrations before or after calving. White blood cell counts did not differ between treatments before or after parturition. The results support our hypothesis that compensatory growth during the last trimester of gestation improves metabolic status of prepartum heifers.

Key Words: Heifer, Transition, Compensatory growth, Blood metabolites

1789 Effects of added rumen undegraded protein and bovine somatotropin administration on skeletal growth rates in prepubertal dairy heifers. U. Moallem^{*1}, G. E. Dahl¹, E. K. Duffey-Tower¹, A. V. Capuco², and R. A. Erdman¹, ¹University of Maryland, College Park., ²USDA-ARS, Beltsville, MD.

The objective of this study was to test effects of added rumen undegraded protein (RUP) and recombinant bST administration on skeletal growth in dairy heifers from 90 days of age until onset of puberty. Fifty Holstein heifers (90 days of age) were used in the experiment and were randomly assigned to one of four treatment groups. Treatments consisted of added dietary RUP (+2%, DM basis) and 0.1 mg/kg BW/d recombinant bST applied in a 2 x 2 factorial design. Weekly blood progesterone concentrations, measured beginning at 180 d, were used to determine onset of puberty. Body weight (BW), wither height (WH), and hip height (HH) were measured every 2 weeks. Average age at puberty (314 ± 23 d) was not affected by treatment ($P > .05$). Daily growth rates for BW, WH and HH were increased by both RUP and bST alone while growth responses to the combination of RUP and bST (RUPbST) were additive. The combination of bST and RUP resulted in 42.8 kg, 2.9, and 2.9 cm increases, respectively in 315 d final BW, WH and HH as compared to Controls. Across treatments, average daily BW gain increased from 647 g/d at 105 d to 1330 g/d at 315 d of age while WH and HH rates decreased from 0.15 and 0.16 cm/d at 105 d to .13 and 0.13 cm/d at 315 d of age, respectively. After 200 to 210 d of age, the combination of bST and RUP was the only treatment that significantly increased rates of BW gain compared to Controls. Skeletal growth rates were increased by added dietary RUP between 90 and 200 d of age, but not later. Conversely, the effects of bST on skeletal growth rates were small at the early ages but increased as the heifers approached puberty. These results suggest that protein limited growth during the early post-weaning period, whereas circulating bST was more important during the time just prior to puberty.

Item	Treatments					Effects <i>P</i> <			
	Control	bST	RUP	RUP bST	SEM	bST	RUP	RUP* bST	
Body weight									
315d, kg	290.4	302.3	306.6	333.2	5.8	0.153	0.011	0.931	
Body weight gain, kg/d	0.935	0.974	0.983	1.091	0.04	0.013	0.006	0.228	
Wither height									
315d, cm	100.6	101.7	102.8	103.5	0.85	0.317	0.024	0.846	
Wither height gain, cm/d	0.134	0.137	0.144	0.150	0.004	0.259	0.005	0.745	
Hip height									
315d, cm	106.4	106.9	108.2	109.3	0.89	0.360	0.021	0.757	
Hip height gain, cm/d	0.139	0.146	0.151	0.159	0.003	0.018	0.001	0.853	

Key Words: bST, RUP, Skeletal growth

1790 Effects of added rumen undegraded protein and bovine somatotropin administration on organ and tissue weights in prepubertal dairy heifers. U. Moallem¹, G. E. Dahl¹, A. V. Capuco², R. L. Baldwin², and R. A. Erdman¹, ¹University of Maryland, College Park, ²USDA-ARS, Beltsville, MD.

Twenty-four dairy heifers were used to determine the effects of added rumen undegraded protein (RUP) and recombinant bST administration from 3 to 10 months of age on organ and tissue weights. The heifers (90 days of age) were blocked randomly into 2X2 factorial trial, which consisted of added dietary RUP (+2%, DM basis) and 0.1mg/kg BW per day of recombinant bovine somatotropin (bST). Twelve heifers, 3 from each group were slaughtered at 5 mo of age and another twelve at 10 mo of age (estimated onset of puberty). Weights of rumen and intestinal tract components including digesta fill along with liver, heart, lungs, spleen and other organs at the time of slaughter. Body weight at 90 d of age was used as a covariate in the statistical analysis to adjust for differences in initial tissue weights. At 5 mo, bST increased the average liver weight by 28.4% compared to Controls and when expressed as a fraction of empty body weight (EBW) by 10% (*P* < 0.05). Rumen undegraded protein increased the empty rumen + reticulum and abomasum weights by 24.4% and 11.5% and as a fraction of EBW by 16% (*P* < 0.01) and 6% (*P* < 0.10) compared with controls, respectively. Rumen digesta fill was increased by 27.3% by added RUP (*P* < 0.05). This enlargement of the anterior digestive tract is consistent with the 10% increased DMI which was observed in the RUP group. At 10 month of age, bST increased the average weights of heart (28%, *P* < 0.01), kidney (22.3%, *P* < 0.01) and liver (17%, NS), and as the relative part of EBW by 15% (*P* < 0.05), 10% (NS), and 5% (NS), respectively. In addition, at 10 mo, omasum, small and large intestine were increased by 22.3%, 22.1% and 22.3%, respectively, by bST administration. These results indicate that administration of bST to growing heifers altered relative organ growth, in a manner that would support increased metabolic activity associated with partitioning of nutrients toward increased protein deposition. In comparison, the added RUP effects were shown only through increased mass of the digestive tract and digesta fill.

Key Words: bST, RUP, Organ weights

1791 Effects of added rumen undegraded protein and bovine somatotropin administration on body composition in prepubertal dairy heifers. U. Moallem¹, K. R. McLeod², A. V. Capuco², K. E. Duffey-Tower¹, G. E. Dahl¹, and R. A. Erdman¹, ¹University of Maryland, College Park, ²USDA-ARS, Beltsville, MD.

The objective of this study was to test effects of added rumen undegraded protein (RUP) and recombinant bST administration on body composition. In a companion growth experiment, added RUP increased rates of BW and skeletal growth early (<200 d age) while bST increased BW and skeletal growth rates at the end of the experiment (>200 d age). Twenty-four Holstein heifers housed and fed with animals in the

growth experiment were randomly assigned to 1 of 4 treatment groups beginning at 90 d of age. Treatments consisted of added dietary RUP (+2%, DM basis) and 0.1 mg/kg BW/d recombinant bST applied in a 2 x 2 factorial design. Twelve heifers, 3 from each treatment group, were slaughtered at 5 mo and another twelve at 10 mo of age. Body weight at 90 d of age was used as a covariate in the statistical analysis to adjust for differences in chemical composition. Across treatments, empty body fat and energy increased with age from 9.1% to 13.9%, and 1.87 to 2.31 mcal/kg at 5 and 10 mo of age (*P* < 0.0001), respectively. There were no significant effects of age on empty body ash and protein content. Across slaughter ages, bST increased ash (*P* < 0.06), tended to increase protein (*P* < 0.13) and decreased body fat content (*P* < 0.05). At 10 mo of age, EB weight was increased by bST, RUP, and bST plus RUP by 23.6, 11.3, and 20.8 kg, respectively. The amounts of body ash (*P* < 0.04) and protein (*P* < 0.07) were increased by bST whereas amounts of body fat were not changed at 10 mo of age. In summary, added RUP did not influence body chemical composition while bST altered body composition at 10 mo by redirecting increased growth towards skeletal development as shown by increased ash and protein deposition.

Mean (5 and 10 mo)	Treatments					Treatments effects (<i>P</i> <)			
	Control	bST	RUP	RUP bST	SEM	bST	RUP	RUP* bST	
Ash, %	4.88	5.29	4.78	5.42	0.25	0.06	0.96	0.65	
Crude protein, %	18.83	19.83	18.61	19.97	0.72	0.13	0.95	0.80	
Fat, %	12.11	11.86	12.03	9.98	0.54	0.05	0.09	0.12	
Energy, mcal/kg	2.11	2.17	2.11	1.97	0.05	0.62	0.12	0.1	
Empty body (10 mo of age)									
Weight, kg	217.4	241.0	228.7	238.2	7.8	0.07	0.60	0.40	
Ash, kg	10.7	12.4	10.5	13.3	0.95	0.04	0.69	0.55	
Crude protein, kg	40.9	47.6	40.4	48.0	3.1	0.06	0.98	0.88	
Fat, kg	31.5	34.6	33.5	28.7	3.1	0.47	0.75	0.16	
Energy, mcal	509.0	576.3	528.6	522.6	34	0.34	0.58	0.26	

Key Words: bST, RUP, Body composition

1792 Relationships between concentration of serum immunoglobulins and growth rate of dairy heifers. W. Jarmuz¹, I. Szlag², and R. Skrzypek², ¹IGiHZ PAN Jastrzebiec, ²Agricultural University of Poznan, Poland.

The study included 115 single-born crossbred Black-and-White heifers that were sampled at the age of 2, 21, 42, 90, 200, and 440 days. At sampling, the heifers were weighed, excepting the day 21 of birth. There were found numerous significant partial correlation coefficients between concentration of serum immunoglobulins and growth rate traits, that were most informative for immunoglobulins determined on the days 2 and 90 after birth. Serum immunoglobulin concentration measured on the day 2 was significantly correlated with body weight at the age of 200 days (*r* = 0.21; *P* ≤ 0.05), and body weight gains measured in different periods within the first 200 days of life (*r* from 0.21 to 0.24; *P* ≤ 0.05). All correlation coefficients between concentration of serum immunoglobulins determined at the age of 90 days and body weight gains measured beginning from the day 2 or 42 after birth were negative and greater than 0.4 (*P* ≤ 0.0001), ranging from -0.42 (42-200 days) to -0.56 (2-90 days). It is concluded, that in growing dairy heifers passive immunity is associated positively with body weight gains during the first 200 days after birth, and that growth rate is associated negatively with immunity acquired actively during the post-colostrum period of life.

Key Words: Heifers, Serum immunoglobulins, Growth rate

1793 Growth Performance, Metabolic and Endocrine Traits in Calves Pair-fed by Automate or by Bucket During the First Month of Life. H.M. Hammon*, A. Nussbaum, G. Schiessler, and J.W. Blum, University of Berne, Switzerland.

Amounts of colostrum (C) and milk intake greatly influence postnatal development of calves. However, as indicated by suckling calves in

natural cow-calf systems, feeding frequencies may also affect postnatal development. In this study growth performance and metabolic and endocrine traits in calves fed C (3 L on d 1, 4 L on d 2, and 5 L on d 3) and milk (5 - 11 L from d 4 up to d 28) by a computer-programmed automate that allowed frequent daily intakes (GrA; n = 7) were compared with calves twice daily pair-fed by bucket (GrB; n = 7). Blood samples were taken after birth on d 1, 2, 14, 21, and 28 before feed intake, on d 3 before and 1, 2, 4, 6 and 8 h after feed intake, and on d 7 every 20 min for 8 h. Plasma concentrations of total protein (TP), urea, glucose, and triglycerides (TG) were measured photometrically. Plasma concentrations of insulin, glucagon, growth hormone (GH), insulin-like growth factor (IGF-I) and thyroxine were measured by RIA. Data were evaluated by analysis of variance using a mixed model with different feeding frequencies and time as fixed effects and the individual calves as random effects. Weight gains did not differ between groups. Plasma TP was higher from d 14 to 28 in GrB than GrA. Plasma glucose increased postprandially (d 3 and 7) in GrB, remained unchanged in GrA, and was higher postprandially (on d 7) in GrA than GrB. Preprandial plasma TG (on d 7) were higher and mean postprandial concentrations (d 7) tended to be higher in GrA than GrB. Insulin concentrations (d 7) tended to be higher in GrA than GrB. During an 8-h period GH (d 7) was higher from 120 to 140 min, but was lower from 240 to 360 min after feeding in GrA than GrB. Plasma IGF-I was higher in GrA than GrB on d 7, 14 and 28. In conclusion, feeding at high frequency with an automate transiently changed some metabolic and endocrine traits, but had no significant effects on growth performance during the first 4 wk of life.

Key Words: Neonatal Calves, Feeding Frequency, Metabolites and Hormones

1794 Age-related changes of the somatotrophic axis in cloned Holstein calves. K.E. Govoni*, X.C. Tian, G.W. Kazmer, M. Taneja, B. Enright, A.L. Rivard, X. Yang, and S.A. Zinn, *University of Connecticut, Storrs, CT.*

Developmental anomalies, as well as high rates of fetal and post-natal mortality have been reported in somatic-cell cloned cattle. Our objective was to determine if the development of the somatotrophic axis in somatic clones (clones) was similar to AI produced heifers (controls). We compared the changes in Growth Hormone (GH), Insulin-like Growth Factor (IGF) -I and IGF Binding Proteins (BP) -2 and -3 of 4 clones generated from a 13-year-old cow with 4 age matched controls from 5 to 15 mo of age. Once a month for 7 mo, serum samples were collected every 30 min for 6 h. Animals were also challenged with GH Releasing Factor (GRF; 3 µg/100kg BW) and Somatostatin (SRIF; 1.87 and 5 µg/100kg BW) at mo 10. Concentrations of GH for clones and controls were compared with 4 post-pubertal heifers (PP; 11 mo of age). Averaged across all time points, concentrations of GH were not different between clones (7.29 ± .96 ng/mL) and controls (5.50 ± .89 ng/mL). However, there was a decline in GH over time in controls, but not in clones (p<.01). GH concentrations in PP animals were less than controls in mo 1 (p<.01) and less than clones in mo 2 (p=.05). When PP, clones and controls were compared at similar ages, concentrations of GH were not different between the three groups. GRF-induced GH secretion was greater in clones than controls (p<.02). SRIF (1.87 µg) inhibition of GRF-induced GH was less (p<.01) in clones than controls. IGF-I concentrations of clones and controls paralleled each other over time. However, overall concentrations of IGF-I were less in clones than controls (203.7 ± 13.8 vs 306.4 ± 13.1 ng/mL). BP-3 was greater in controls than clones (85 ± 3.7 vs 70 ± 3.7%), but did not change over time for either group. BP-2 did not change over time and average concentrations were not different between clones and controls. Although, there were some differences in measures of the somatotrophic axis between these clones and these age-matched controls, values of each variable measured were within reported ranges for cattle of similar ages, indicating that these clones have normal development, in terms of the somatotrophic axis. However, further studies are required using clones derived from different cell types and from different donor animals to validate this conclusion.

Key Words: Somatic Cell Derived Clones, Growth Hormone, Insulin-like Growth Factor-1

1795 Feed Intake Patterns, Metabolic and Endocrine Traits, and Growth Performance During the First Month of Life of Calves Provided Restricted or Unlimited Amounts of Colostrum and Milk with an Automate. J.W. Blum*, A. Nussbaum, G. Schiessler, and H.M. Hammon, *University of Berne, Switzerland.*

Amounts of colostrum (C) and milk intake greatly influence postnatal development of calves. Automatic feeding systems allow calves to drink high amounts of C and milk divided into several small portions per d. In this study growth performance and metabolic and endocrine traits were compared in calves fed by a computer-programmed automate either restricted amounts of C (GrR; n = 7) and milk or C and milk ad libitum (GrL; n = 7). Feed intake and meal frequencies were measured by the automate. Blood samples were taken after birth on d 1, 2, 14, 21, and 28 before feed intake and on d 3 and 7 before and 1, 2, 4, 6 and 8 h after feed intake. Plasma concentrations of total protein (TP), albumin, glucose, non-esterified fatty acids (NEFA), triglycerides and cholesterol were measured photometrically. Plasma concentrations of insulin, glucagon and insulin-like growth factor (IGF-I) were measured by RIA. Data were evaluated by analysis of variance using a mixed model with different feeding frequencies and time as fixed effects and the individual calves as random effects. There were group differences of dry matter intakes and meal sizes per visit (GrL > GrR) and total visits (with and without milk intake) at the automate (GrR > GrL). Feed intake in GrL increased from 1 to 4 d, then remained stable and was always higher than in GrR. Weight gain was greater in GrL than GrR in wk 1. There were significant group differences of plasma concentrations of TP (GrL > GrR; d 28), albumin (GrR > GrL; d 1 - 2), cholesterol (GrR > GrL; d 28), NEFA (GrR > GrL; d 1 - 2), insulin (GrL > GrR; d 1 - 2), and IGF-I (GrR > GrL; d 1 and 28). In conclusion, calves fed by automate ad libitum were capable of ingesting high amounts of C and milk already during wk 1 of life. High C and milk intakes in GrL were accompanied by moderate metabolic and endocrine changes. High weight gains in wk 1 could not be maintained up to 1 month.

Key Words: Feeding intensity, Growth performance, Metabolites and Hormones

1796 Glucose metabolism in Holstein and Jersey calves fed milk replacer once versus twice daily. C. M. Cheatham*¹, C. C. Williams¹, J. M. Fernandez¹, W. A. Nipper¹, H. G. Bateman, II¹, J. C. Lovejoy², D. T. Gantt¹, L. R. Gentry¹, and G.E. Goodier¹, ¹Louisiana State University Agricultural Center, Baton Rouge, LA, ²Pennington Biomedical Research Center, Louisiana State University, Baton Rouge, LA.

Eighteen Holstein and fifteen Jersey heifer calves were fed milk replacer (MR) once (1x) or twice (2x) daily to determine effects of two feeding systems on glucose metabolism during the neonatal period. From birth to 5d of age all calves were fed colostrum or whole milk. From d5 to d6 of age, all calves were fed MR 2x. Beginning on d7 of age, calves fed 2x were offered 15g MR DM/kg birth weight reconstituted to 15% DM. Calves fed 1x were offered 15g MR DM/kg birth weight reconstituted to 21%DM. At 5 wk, MR was decreased by 50% for all calves followed by abrupt weaning at 6 wk. Calves were allowed free access to calf starter and water throughout the study. At weeks 3 and 6, Minimal Model intravenous glucose tolerance tests were performed to assess glucose effectiveness (S_G), an estimate of insulin-independent glucose disappearance; insulin sensitivity (S_I), an estimate of insulin-dependent glucose disappearance; and acute insulin response ($AIR_{glucose}$), insulin secretion relative to glucose administration. Of the three parameters measured, Jersey calves differed from Holsteins only by having greater S_I ($P < 0.05$). The S_I and S_G were similar for calves regardless of MR feeding frequency ($P > 0.10$). However, S_I decreased with age for all calves ($P < 0.05$) while $AIR_{glucose}$ increased with age ($P < 0.05$). In calves fed MR 2x, $AIR_{glucose}$ was greater than in calves fed MR1x ($P < 0.05$). These data suggest that feeding calves MR 1x versus 2x did not significantly affect glucose metabolism during the neonatal period.

Key Words: Calves, Glucose metabolism, Insulin sensitivity

1797 Evaluation of bovine or porcine plasma in calf milk replacers on mortality, morbidity, intake and growth of young dairy calves. J. D. Quigley, C. J. Kost, and T. M. Anspach*, APC Company, Inc., Ames, IA.

Replacement of a portion of the whey protein concentrate with spray-dried animal plasma in calf milk replacer (CMR) formulations can provide a source of immunologically active IgG without markedly affecting digestibility or intake. However, data indicating the importance of the species origin of animal plasma are lacking. In this study, Holstein bull calves (n = 120) at the APC Company Research Facility in Ames, IA were fed one of three CMR for 42 d. Experimental CMR were formulated to contain whey protein concentrate (WPC) as the primary protein source or WPC plus 5% spray-dried bovine plasma (SDBP) or WPC plus 5% heat stable porcine plasma (SDPP). Calves were also offered commercial calf starter and water for ad libitum consumption. Mortality was reduced from 25% to 7.5% and 5.0% when calves were fed CMR containing WPC, SDBP, or SDPP, respectively. Morbidity, measured as number of days that calves had diarrhea (scours) was reduced by 30% (P < 0.01) when SDBP or SDPP were fed. Mean number of days with scours were 6.1, 3.9 and 4.7 d for calves fed WPC, SDBP and SDPP, respectively. Fecal scores during the 42-d study tended to be reduced (P < 0.10) and feed efficiency tended (P < 0.10) to be improved when SDBP or SDPP was fed. Mean fecal scores (1 = normal feces to 4 = severe scours) were 1.66, 1.59 and 1.61 for calves fed CMR containing WPC, SDBP and SDPP, respectively. Mean feed efficiency was 170, 265 and 211 g of BW gain/kg DM intake, respectively. Calves fed SDPP tended (P < 0.10) to consume less starter, total DM and protein compared to calves fed SDBP and tended (P < 0.10) to have lower BW gain during the first 28-d of the study. Mean BW gain from d 0 to d 28 was 83, 119 and 80 g/d for calves fed WPC, SDBP and SDPP, respectively. There were no differences in BW gain after 28 d, and calves ended the study weighing 56.4, 58.2, and 56.8 kg, respectively. Both SDBP and SDPP were effective in reducing morbidity and mortality during the trial and may be effective adjuncts to a calf management program.

Key Words: calves, milk replacer, immunity

1798 Body composition of Piedmontese x Hereford and Wagyu x Hereford newborn calves. P.L. Greenwood*^{1,2}, H. Hearnshaw^{1,3}, D.W. Hennessy^{1,3}, J.M. Thompson^{1,4}, and G.S. Harper^{1,5}, ¹Cooperative Research Centre for Cattle and Beef Quality, Armidale, Australia, ²NSW Agriculture Beef Industry Centre, Armidale, Australia, ³NSW Agriculture Research and Advisory Station, Grafton, Australia, ⁴University of New England, Armidale, Australia, ⁵CSIRO Livestock Industries, Brisbane, Australia.

Newborn calves of extreme genotypes for marbling and muscle growth potential were studied to provide base-line data for studies aimed at elucidating the cellular basis and regulation of growth and development of carcass tissues. Female calves born to Hereford cows and sired by Piedmontese (PxH calves, LW range 31.4 to 42.0 kg, n = 10) or Wagyu (WxH calves, 27.6 to 35.4 kg, n = 8) bulls were slaughtered within 24 h of birth. Organs and selected muscles and body tissues were dissected out and weighed. Empty body weights were determined, and carcasses prepared to a standard before being Computer Tomography (CT)-Scanned. Carcass composition was determined by integration of cross-sectional tissue areas from serial CT body scans. As a proportion of empty body weight, PxH calves had (P < .05) higher dressing percentage than WxH calves (mean \pm SEM, 57.6 \pm .6% vs 54.9 \pm .5%, respectively), more carcass lean (75.1 \pm .4% vs 72.9 \pm .6%), less carcass fat (4.8 \pm .1% vs 5.2 \pm .1%) and bone (20.1 \pm .4% vs 21.9 \pm .5%), larger *M. semitendinosus* (.45 \pm .01% vs .38 \pm .01%) and *M. longissimus et lumborum* (.46 \pm .02% vs .39 \pm .02%), and lower combined weight of organs (9.0 \pm .1% vs 10.2 \pm .2%). PxH calves also tended to have less skin (11.5 \pm .3% vs 12.3 \pm .3%, P < .10) than their WxH counterparts, but there was no difference in the proportion of abdominal plus kidney fat (.55 \pm .04% vs .61 \pm .04%, P > .10). When adjusted for differences in empty body weight, significant effects (P < .05) remained for weight of fat in the carcass, weight of *M. semitendinosus* and combined weight of organs. The results demonstrate that differences in the distribution of body tissues between Wagyu x Hereford and Piedmontese x Hereford cattle are apparent at birth.

Key Words: Cattle, newborn, body composition

1799 Post-weaning growth of cattle destined for Japanese and Korean markets: Relationships between growth during backgrounding and intramuscular fat percentage (IMF%) at slaughter. M.J. McPhee^{1,2}, S. Harden^{1,3}, P.L. Greenwood*^{1,2}, and V.H. Oddy^{1,4}, ¹Cooperative Research Centre for Cattle and Beef Quality, Armidale, Australia, ²NSW Agriculture, Beef Industry Centre, University of New England, Armidale, NSW 2351, Australia, ³NSW Agriculture, Tamworth Centre for Crop Improvement, Tamworth, NSW 2340, Australia, ⁴Meat and Livestock Australia, 165 Walker Street, North Sydney, NSW 2060, Australia.

Effects of growth rate during backgrounding (weaning to commencement of finishing) on intramuscular fat percentage (IMF%) at slaughter of beef cattle destined for Japanese or Korean markets were assessed. Cattle were grazed on temperate perennial pastures on the Northern Tablelands of NSW, Australia (4 experimental years; years 1 to 4, n=329, 273, 290 and 107, respectively). Angus, Hereford, Murray Grey and Shorthorn steers were grown either without supplementation or with supplementary feeding of high protein pellets or with access to a forage crop to an overall group mean target LW of 400 kg. They were finished either on pasture or in the feedlot for Korean (average LW 520 kg) or Japanese (average LW 600 kg) market weights. IMF% was measured on a sample of *m. longissimus* at the 12/13th rib using near infrared spectroscopy. The variance in IMF% was analysed for each year by fitting a mixed linear model; the terms were market category, finishing system, market category x finishing system, breed, carcass weight and backgrounding growth rate. All terms contributed significantly to IMF% (P < .05). The proportions of total variation in IMF% accounted for across the years were: market (.9% to 22%), breed (7% to 14%), carcass weight (1% to 8%), market category x finishing system (.9% to 9%), finishing system (16% to 31%), backgrounding growth rate (.7% to 6.1%) and unexplained (residual) variation (30% to 63%). The results show that backgrounding growth rate had a small positive effect on IMF%, and that finishing system had a greater effect on IMF%. However, the high degree of unexplained variation supports the need for further investigations into factors affecting IMF% at different market weights.

Key Words: Cattle, growth rate, intramuscular fat

1800 Effect of Synovex-S[®] on pituitary-thyroid axis response to challenge with a combination of thyrotropin releasing hormone (TRH) and growth hormone releasing hormone (GHRH) in beef steers. S. Kahl*, T.S. Rumsey, and T.H. Elsasser, USDA, Agricultural Research Service, Beltsville, MD.

Thyroid status is an important regulator of growth. Studies have suggested that thyroid hormones may be involved in the mechanism of action of estrogen-based growth promoters in steers. This study evaluated the effect of Synovex-S[®] ear implants (SYN, 20 mg estradiol benzoate + 200 mg progesterone) on basal and TRH/GHRH-stimulated plasma concentrations of thyrotropin (TSH), thyroxine (T₄), and triiodothyronine (T₃), and on hepatic and pituitary 5'-deiodinase (5'D) activity. Sixteen crossbred steers (404 \pm 13 kg) were fed individually a 30:70 silage:concentrate diet (17.8% CP, 2.87 Mcal ME/kg DM) to gain 1.2 kg BW daily and assigned to no implantation (control) or implantation (n = 8). Two days before and 14, 28, 42, and 56 d after implantation, all steers were challenged (i.v.) with a combination of TRH + GHRH (1.0 + 0.1 μ g/kg BW, respectively). For each challenge jugular blood samples were obtained at 0, 10, 20, 30, 40, 60, 120, 240, and 360 min after challenge for TSH analysis and at 0, 1, 2, 4, 6, 8, 12, and 24 h after challenge for T₄ and T₃ analyses. Primary response to challenge was measured as area under the time x concentration curve (AUC). Liver and pituitary samples were collected at slaughter 5 d after the last challenge. Compared to control steers, SYN did not affect (P > 0.05): (a) basal plasma concentrations of TSH, T₄, and T₃, (b) TSH and T₃ responses to TRH + GHRH challenge at any time after implantation, and (c) 5'D activity in liver (type-I) and pituitary (type-II). However, SYN increased T₄ response to each TRH + GHRH challenge (742 vs 589 ng/mL x h, SEM = 52, P < 0.05). Results indicate that the primary action of SYN on the pituitary-thyroid axis in steers is greater sensitivity of the thyroid gland to TSH stimulation resulting in increased T₄ secretion.

Key Words: Growth promoters, Thyroid hormones, Thyrotropin

1801 Performance, carcass characteristics and plasma levels of thyroid hormones and insulin like growth factor-I in feedlot intact crossbred (*Bos taurus* × *Bos indicus*) Brazilian Superyoung System. L. A. L. Chardulo^{*1}, J. A. Ferro², A. C. Silveira¹, L. R. Furlan¹, M. D. B. Arrigoni¹, H. N. Oliveira¹, M. I. T. Ferro², and M. Macari², ¹UNESP - Botucatu, SP/Brazil, ²UNESP - Jaboticabal, SP/Brazil.

The objective of this study was to evaluate the performance, carcass characteristics and the levels of metabolic hormones in male and female young cattle of different genetic groups kept in feedlots and slaughtered at 12 months of age. Two-hundred male and female young cattle, crossbred from males of five breeds (Charolais, Gelbvieh, Aberdeen Angus, Hereford and Simmental) and Simmental × Nellore crossbred females, were weaned at seven months of age and kept in feedlots for 180 days in a completely randomized design. Diets were formulated according to the age (growth and finishing phases) and weight of animals. The performance was evaluated by weight gain and slaughter weight. The plasma levels of thyroid hormones were evaluated by EIA and the levels of IGF-1 by RIA. Hereford animals had a higher slaughter weight when compared to the other breeds ($p < .01$). Males had better performance than females for all characteristics evaluated ($p < .01$). Ultrasonography measurements showed a higher marbling rate in Aberdeen Angus animals, as well as lower hindlimb percentage and chilling losses, which resulted in a higher fat index in the carcass ($p < .01$). Aberdeen Angus animals had higher triiodothyronine (T_3) levels and higher IGF-1 levels during finishing phase as compared to the other breeds ($p < .01$). Correlations between T_3 and subcutaneous fat ($r = 0.76$, $p < .01$) and marbling ($r = 0.79$, $p < .01$) were significant as well as between IGF-1 and subcutaneous fat ($r = 0.67$, $p < .01$) and marbling ($r = 0.59$, $p < .01$). Among the breeds considered in this study, Aberdeen Angus seems to be the most adequate to be used in crossings for intensive meat production like the Brazilian Superyoung System.

Key Words: Crossbred cattle, Meat production, Plasma hormones

1802 Effects of estradiol administration and level of protein intake on nitrogen metabolism and insulin-like growth factor-1 (IGF-1) gene expression in muscle in growing steers. O Cheng^{*1}, W Knaus¹, M Boehm¹, and D Beermann^{1,2}, ¹Cornell University, ²University of Nebraska at Lincoln.

Modulation of IGF-1 expression in muscle was assessed using a ribonuclease assay developed to quantify the abundance of IGF-1 mRNA in ovine and bovine tissues. Four Holstein steers weighing 250 kg were fed a low-protein diet (7.6% CP) or a diet supplemented with urea to meet the ruminal requirement for N (12.2% CP) and administered twice-daily subcutaneous injections of estradiol-17 beta (500 micrograms at 12-hr intervals) or excipient using a 4 × 4 Latin Square design. Daily N retention increased from 10 to 18 g/d and plasma urea nitrogen (PUN) increased from 3.6 to 7.8 mg/dL (both $P < 0.05$) when the higher protein diet was fed. The higher level of protein intake increased IGF-1 mRNA abundance in the semimembranosus muscle to 189% of control levels ($P = 0.07$), and circulating IGF-1 concentration was not altered. Estradiol administration increased plasma estradiol 18-fold (2.4 to 48.5 pg/ml) but did not alter plasma PUN or IGF-1 gene expression in skeletal muscle (all $P > 0.1$). An interaction between protein intake and estradiol treatment was observed for IGF-1 mRNA abundance in skeletal muscle ($P = 0.11$). When the higher protein diet was fed estradiol treatment increased IGF-1 mRNA abundance in skeletal muscle 42% compared to excipient treatment. Results from this study indicate that skeletal muscle growth in steers may be controlled through autocrine or paracrine influence of IGF-1 mRNA abundance. The short-term twice-daily estradiol administration failed to enhance N balance, suggesting that either a longer treatment period or a higher level of protein intake is necessary for estradiol to exert its anabolic effect in growing Holstein steers.

Key Words: Muscle growth, IGF-1, estradiol

1803 Temporal effects of daily estradiol administration on nitrogen metabolism and insulin-like growth factor-1 (IGF-1) gene expression in liver and skeletal muscle in growing lambs. O Cheng^{*1}, M Boehm¹, and D Beermann^{1,2}, ¹Cornell University, ²University of Nebraska at Lincoln.

Twelve Suffolk-sired crossbred wether lambs weighing 23 kg were fed a diet containing 67% barley, 15% soy hulls and 13.5% soybean meal (15.6% CP). The objective was to assess the temporal effects of subcutaneous estradiol administration (175 micrograms at 12-h intervals) on plasma estradiol, urea nitrogen (N) and IGF-1 concentrations, on daily N balance, and IGF-1 gene expression in liver and skeletal muscle. A ribonuclease assay was developed to quantify IGF-1 mRNA abundance in muscle and liver RNA samples. Daily N balance and jugular blood samples were collected from all lambs over a 7-day control period. During the following 7-day estradiol treatment period two lambs were euthanized each day at 1, 2, 3, 4, 5, and 7 days for liver and muscle sample collection. Daily N balance samples were collected from each lamb until removed for tissue sample collection. Subcutaneous administration of estradiol increased plasma estradiol concentration 17-fold (from 50 to 450 pg/ml) within 15 min of injection and maintained concentrations at 300 pg/ml at 75 min and 150 pg/ml 300 min after administration ($P < 0.01$). Estradiol administration did not alter daily fecal and urinary N excretion, daily N balance, biological value, or PUN concentration (all $P > 0.05$). Likewise, circulating IGF-1 concentration, and liver, semitendinosus and longissimus muscle IGF-1 mRNA abundance were not altered at any of the treatment intervals (all $P > 0.05$). The lack of anabolic response to estradiol administration was unexpected. Control period variable means for N balance (11 g/d), biological value (0.59) and PUN concentrations (15 mg/dL) were higher than expected. These data suggest that the lambs were receiving adequate protein intake and may have been too close to their genetic potential for rate of protein gain, or that the treatment period was too short for a response to estradiol administration to be observed.

Key Words: Estradiol, N balance, IGF-1 expression

1804 Effects of immunization against LHRH on growth performance, sex characteristics, and meat quality of intact male pigs. C. Y. Liu^{*1}, L. C. Cheng¹, P. C. Yang¹, T. Y. Chang^{2,3}, M. Shen³, C. L. Finstad³, and C. Y. Wang^{2,3}, ¹Pig Research Institute Taiwan, ROC, ²United Biochemical, Inc., Asia, ROC, ³United Biochemical, Inc., USA.

Twenty-two young intact male pigs were used in an 18-week growth assay to determine the effects of immunization against LHRH on growth performance, sex characteristics, and meat quality. At 20 kg BW and 8 weeks later, control animals (C) were injected with vehicle only, and the remaining males were immunized with an anti-LHRH peptide vaccine at either 40 (L) or 100 (H) μ g per injection. Compared with control intact males, immunized pigs tended ($P < .1$) to have high ADG (for C, L, H; 698, 765, 837 g/d) and ADFI (1.78, 1.92, 2.14 kg/d) with no changes in F/G ratio (2.55, 2.55, 2.58). Greater backfat (2.17, 2.65, 2.91 cm) and loin eye area (45.9, 44.8, 56.2 cm²) were detected in pigs treated with anti-LHRH vaccine at 100 μ g level ($P < .05$). Tenderness and juiciness of longissimus muscle chops did not differ among groups by sensory panel evaluations, but chops from immunized animals had less off-flavor ($P < .01$) than intact controls. Genital tract weights (testes, epididymes, seminal vesicles, and prostate glands), measured at slaughter, were significantly ($P < .001$) decreased by immunization, and both doses of anti-LHRH vaccine had similar efficacy. Consistently, plasma testosterone concentrations were completely inhibited ($P < .001$) by anti-LHRH vaccine. The present results demonstrate that anti-LHRH immunization is an effective means to inhibit sexual development and to reduce incidence of boar taint for intact male pigs.

Key Words: Pigs, Immunocastration, LHRH

1805 The effects of zinc and thyroid hormone on the expression of growth hormone and thyroid stimulating hormone in primary rat anterior pituitary cells. A.L. Rivard^{*}, M.A. Shaller, H.C. Freake, and S.A. Zinn, University of Connecticut.

Chelation of zinc with DTPA (diethyltriaminepentaacetic acid) stimulates expression of growth hormone (GH) in tri-iodothyronine (T_3)-treated rat pituitary tumor (GH3) cells. To determine whether zinc chelation stimulates GH expression in rat anterior pituitary cells, 50 to

60 weanling CD rats (5 wk old; 75 g BW) were euthanized and anterior pituitary glands removed. Individual cells were dispersed with dispase and cells were maintained at 37C (humidified atmosphere; 95% air: 5% CO₂) in Dulbecco modified Eagle's medium for 24 h. Cells were then treated with one of the following (2 wells /treatment; replicated in 3 experiments): 1. controls; 2. 10 nM T₃; 3. 50 M DTPA; 4. 10 nM T₃ plus 50 M DTPA; and 5. 10 nM T₃, 50 M DTPA and 40 M zinc sulfate. Cells were incubated for 48 h prior to RNA extraction. Reverse transcription (RT) PCR, with specific primers for GH and thyroid stimulating hormone (TSH), was used to measure mRNA levels. Comparisons with control gene-specific primers RPL-32 and β -actin were used to calculate mRNA levels of expression for GH and TSH, respectively. To evaluate RT-PCR, preliminary experiments were performed with GH3 cells. Results with RT-PCR and the GH primer paralleled previous results using Northern analysis, showing that expression DTPA and T₃ stimulated GH mRNA expression. TSH was measured to confirm the viability of the anterior pituitary cells. As expected, T₃ inhibited TSH mRNA expression 50% compared to control cells. Expression of TSH mRNA was greater in DTPA treated cells compared with controls ($p < .01$), but was lowered by combination with T₃ and by combination with T₃ and zinc. These results confirm that the anterior pituitary cells are viable and responsive. In these same cells DTPA alone reduced GH mRNA levels by 25% ($p = .03$). However, in contrast to GH3 cells, DTPA did not stimulate GH mRNA levels in T₃-treated pituitary cells ($p = .18$). In conclusion, while zinc chelation increases TSH mRNA, in the presence or absence of T₃, it does not affect the GH mRNA in primary rat anterior pituitary cells in the same manner as GH3 cells.

Key Words: Rat, Growth hormone, Thyroid hormone

1806 Effects of dietary conjugated linoleic acid (CLA) on the composition and function of peripheral blood mononuclear leukocyte populations in heifer calves. J.M. Smith*¹, B.J. Nonnecke², M.E. Van Amburgh¹, B.A. Pesch², and J.A. Harp², ¹Cornell University, Ithaca, NY, ²National Animal Disease Center (NADC), USDA, ARS, Ames, IA.

At approximately 2.5 months of age, heifer calves, raised and housed at the Cornell University Dairy Teaching and Research Facility, began receiving a diet formulated to support 1 kg/d gain (controls, n = 6) or a diet containing protected CLA (treated, n = 6). Total CLA was included in the diet at 1% of DM intake. The CLA-supplemented diet was formulated to support the same levels of ME and MP allowable gain as the control diet. Peripheral blood was collected at the initiation of the study (100 kg BW) and at 6.5 (200 kg BW) and 9.5 (300 kg BW) months of age. Anti-coagulated blood was maintained at room temperature and shipped overnight to the NADC where the composition and function of circulating mononuclear leukocyte (PBML) populations were evaluated. The composition of PBML populations was evaluated by flow cytometry. The total number of PBML was unaffected ($P > 0.05$) by dietary treatment or age. Percentages of CD3+ T cells (and CD4+, CD8+, and $\gamma\delta$ T cell subsets) and B cells in the PBML population were unaffected ($P > 0.05$) by dietary CLA; however, the proportion of T cells did increase ($P < 0.01$) with age. Percentages of PBML expressing activation

antigens (i.e. MHC class II antigen and interleukin-2 receptor) were also unaffected by dietary CLA or age. Leukocyte function was evaluated in vitro by measuring interferon- γ (IFN- γ), nitric oxide, and tumor necrosis factor- α secretion in PBML cultures, both unstimulated and mitogen-stimulated (i.e. with pokeweed mitogen (PWM), concanavalin A, and phytohemagglutinin-P). In general, dietary CLA did not affect these functions. The only exception was greater IFN- γ secretion by PWM-stimulated cells from heifers supplemented with CLA. Although these data suggest dietary CLA had minimal effect on the composition and function of PBML from healthy calves, additional research is needed to determine if dietary CLA would benefit calves experimentally or naturally infected with pathogens causing significant morbidity or mortality in the field.

Key Words: Conjugated linoleic acid, Immune function, Dairy heifers

1807 Feeding conjugated linoleic acid to reduce the impact of an infectious disease challenge in growing swine. J.A. Brown*, G.W. Almond, S.A. Mathews, W.T. Oliver, and R.J. Harrell, North Carolina State University, Raleigh, NC.

Respiratory diseases, particularly in the grow-finish phase, account for considerable economic loss in the swine industry. Studies in chicks and rodents have shown dietary conjugated linoleic acid (CLA) reduced the catabolic effects of a noninfectious inflammatory challenge. Our objective was to maintain performance and/or reduce the duration of lower performance during an infectious disease challenge of porcine reproductive and respiratory syndrome virus (PRRSV) and *M. hyopneumoniae* (*M. hyo.*) by supplementing diets with CLA. Pigs were weaned from the sow at 12 days of age and reared in isolated facilities to ensure high health status. At 26.7 \pm 0.6 kg BW, 16 barrows were moved to metabolism cages and randomly assigned to a 2x2 factorial arrangement: diet (0 or 2% CLA-60) and disease challenge (uninfected or infected with PRRSV and *M. hyo.*). Pigs were allowed a 2 week adjustment period to their respective diet prior to infection. Pigs were then inoculated with PRRSV and *M. hyo.*, and control pigs were given sterile media. Blood samples were taken weekly, and total urine and feces were collected during the third week post infection. Pigs were euthanized at a constant BW of 63.4 \pm 1.1 kg. PRRSV titers were not present initially, and only infected pigs were positive at the conclusion of the trial. In addition, only infected pigs had lung lesions typical of *M. hyo.* No differences in average daily feed intake, efficiency of gain, N-retention, plasma urea nitrogen, or total blood protein were found ($P > 0.11$). Infected pigs had lower blood albumin ($P < 0.03$) and tended to have reduced ADG ($P < 0.06$) compared to uninfected pigs, but dietary CLA did not attenuate the reduced growth performance ($P > 0.20$). Results thus far suggest that CLA does not attenuate the reduced growth performance associated with an infectious disease challenge. However, beneficial effects of CLA may have been compromised by the lack of severity of the disease challenge.

Key Words: Swine, Conjugated linoleic acid, Disease

AMSA/ASAS Meat Science and Muscle Biology

1808 Prediction of the fat content of pork carcasses based on cross-sectional region analysis of dual energy X-ray absorptiometry scans. A. D. Mitchell*¹, A. M. Scholz², and V. G. Pursel¹, ¹USDA, Agricultural Research Service, Beltsville, MD, ²Ludwig Maximillians University-Munich, Oberschleissheim, Germany.

Dual energy X-ray absorptiometry (DXA) can be used to measure pork carcass composition by performing a total scan of the half-carcass. The scan can be analyzed for total or regional fat, lean, and bone mineral content, but is too slow for on-line slaughter application. The purpose of this study was to determine the feasibility of predicting carcass composition based on a single cross-sectional measurement. A total of 252 right half-carcasses (42.7 \pm 5.2 kg) were scanned by DXA. The DXA scans were analyzed for percentage fat in the entire half-carcass as well as the shoulder, ham, loin, and side regions. A total of 14 cross-sections (57.6 mm wide) were analyzed: 6 in the shoulder/thoracic region, 3 in the loin region, and 5 in the ham region. Regression analysis was used to compare the DXA fat percentage measurements in the total carcass with those of the various regions. The mean fat content of the half-

carcasses was 24.1 \pm 7.0%; shoulder region, 23.8 \pm 6.7%; ham region 22.9 \pm 6.7%; loin region, 23.7 \pm 7.6%; and the side region 27.9 \pm 7.6%. The correlation (R^2) between the fat content of a single cross-sectional slice and total fat content ranged from 0.908 to 0.976. The highest correlations were in the area of the last ribs. Based on previous results, it is estimated that a single slice could predict the percentage of carcass fat by chemical analysis with an R^2 of 0.80. The highest correlations between single cross-section and region analysis were: shoulder, 0.978; ham, 0.972; loin, 0.973; and side, 0.959. These results indicate that carcass fat percentage can be measured by performing a single-pass cross-sectional scan that would be compatible with on-line processing.

Key Words: Carcass Composition, DXA, Swine

1809 Effect of supplemental fat on growth performance and quality of beef from steers fed barley-potato product finishing diets I. Feedlot performance, carcass characteristics, and appearance. M. L. Nelson*, J. R. Busboom, D.J. Marks, L.F. Falen, and J.D. Cronrath, *Washington State University, Pullman, WA/USA*.

To measure effects of dietary fat on feedlot performance, carcass characteristics, and beef appearance, one hundred sixty-eight crossbred steers (318 ± 2.8 kg) were allotted within weight block (3) to a randomized complete block design with a $2 \times 3 + 1$ factorial arrangement of dietary treatments. Main effects were level of yellow grease (0, 3, or 6%) and level of alfalfa hay (3.5 or 7%) with the added treatment of 6% tallow and 7% alfalfa hay in barley-based diets containing 15% potato by-product and 7% supplement fed for 165 d. Dietary treatment did not affect ($P > .10$) DM intake ($8.2 \pm .17$ kg/d), ribeye area ($87.1 \pm .58$ cm²), beef brightness ($2.5 \pm .06$) on a 1 (very dull) to 5 (very bright) scale, or beef texture ($2.6 \pm .05$) on a 1 (very coarse) to 5 (very fine scale). Level of yellow grease linearly increased ($P < .05$) average daily gain from 1.5 to $1.6 \pm .16$ kg/d, diet NE_m from 2.4 to $2.6 \pm .06$ Mcal/kg, and diet NE_g from 1.7 to $1.9 \pm .04$ Mcal/kg, and kidney, pelvic and heart fat from 2.1 to $2.4 \pm .06\%$. Level of yellow grease linearly decreased ($P < .05$) feed-to-gain from 5.9 to $5.5 \pm .16$, beef firmness score from 3.0 to $2.8 \pm .07$ on a 1 (very soft) to 5 (very firm) scale, and fat luster score from 3.1 to $2.8 \pm .09$ on a 1 (very dull) to 5 (very lustrous) scale. Level of alfalfa hay by itself did not affect any of the measurements, however it interacted with level of yellow grease on backfat, marbling score, beef color score, and percentage USDA Choice. Backfat increased with yellow grease in 3.5% but not in 7% alfalfa diets. Marbling and beef color score were maximized in the 3.5% alfalfa hay diet but minimized in 7% alfalfa hay diet that contained 3% yellow grease. Steers fed tallow had lower ($P < .10$) marbling scores (272 vs 295 ± 5.54 where 300 was choice 0), percentage USDA Choice (21 vs $43 \pm 7.71\%$) but greater ($P < .10$) beef firmness score [3.0 vs $2.7 \pm .10$] on a 1 (very soft) to 5 (very firm) scale than those fed yellow grease. Therefore, yellow grease increased diet energy which improved gain, feed-to-gain, and slightly increased carcass fatness. Yellow grease also increased marbling and decreased beef firmness and fat luster.

Key Words: Barley, Yellow grease, Tallow

1810 Catalysis of meat tenderization during post-mortem aging by calpain 3 (p94). M. A. Ilian*, A. E. Bekhit, and R. Bickerstaffe, *Lincoln University*.

The biochemical basis of postmortem tenderisation of meat is the proteolysis of certain muscle structural proteins by the calpain proteolytic system. In mammalian skeletal muscle, calpains comprise the ubiquitous calpains 1 and 2 and the tissue-specific calpain 3 or p94. The results of our previous studies on the role of calpains in meat tenderization revealed, for the first time, a strong correlation between the variation in meat tenderness and the expression of calpain 3 at the mRNA and protein levels. Furthermore, it was observed that calpain 3 was terminally activated, like calpain 1, during postmortem storage. To investigate further the mechanism of meat tenderisation, we have determined the kinetics of; i) meat tenderisation, ii) myofibrillar fragmentation index (MFI), iii) proteolysis of nebulin and, iv) the activation of calpain 3 in the longissimus over a period of 7 days post slaughter. The results indicate there is agreement between the kinetics of tenderization and the kinetics of MFI, nebulin and the activation of calpain 3. The correlation coefficients between the kinetics of meat tenderization and the kinetics of MFI, nebulin and the activation of calpain 3 were 0.75 , -0.77 , and -0.86 respectively. These results support the statement that the biochemical basis of postmortem tenderisation of meat is the proteolysis of certain muscle structural proteins, such as nebulin, by the calpain proteolytic system. At this point in time, we can not be certain which calpain is rate limiting in postmortem tenderization, but the results support a potential role for calpain 3 in this process.

Key Words: Meat tenderization, proteolysis, calpain 3(p94)

1811 Effect of transport temperature and post-slaughter chilling on channel catfish fillet quality. B. G. Bosworth*¹, W. R. Wolters¹, J. Silva², and R. Chamul², ¹USDA-ARS, Stoneville, MS, ²Mississippi State University, Starkville, MS.

Objectives were to determine effects of transport water temperature and post-slaughter chilling on channel catfish fillet quality. Channel catfish (mean weight = 0.67 kg) were harvested from commercial ponds and transported in a 4-compartment trailer at a typical commercial transport density (440 kg fish/m³ water). Each compartment was assigned to one of four treatments with 3 replicate trials: Treatment 1 (T1) = transport water temperature 20°C , fillets chilled (typical industry practice); Treatment 2 (T2) = transport water temperature 20°C , carcasses chilled prior to filleting; Treatment 3 (T3) = transport water temperature 10°C , fillets chilled; and Treatment 4 (T4) = transport water temperature 1°C (slush ice), fillets chilled. After 3.5 h transport, 10 fish from T1, T2, and T3 were returned to pond water to simulate fish being rejected at the plant and returned to the producer. Remaining fish were stunned by electricity and processed. Fillet texture, color (CIE L*, a*, b*), purge-loss, and pH were measured. Mortality of fish returned to pond water was higher ($P < 0.05$) in T4 (97%) than in T1 (3%) and T3 (3%). Fillet texture (FTC Texture Meter) was not different ($P > 0.05$) among treatments. Purge-loss during 3 d iced-storage was highest ($P < 0.05$) in T1 (1.46%), but not different among T2 (1.08%), T3 (1.10%), and T4 (1.00%). Fillet L* values were higher ($P < 0.05$) for T1 (54.7) and T2 (53.8) than for T3 (51.6) and T4 (51.8). T3 fillets had lower a* values (-2.0) than T1 (-1.4), T2 (-1.6) or T4 (-1.6). Fillet b* values were highest for T1 (2.0), intermediate for T2 (1.0) and T4 (1.2), and lowest for T3 (0.4). Purge-loss was positively correlated with L*, a*, and b* values ($p < 0.001$). Ultimate pH of fillets was higher ($P > 0.05$) for T1 (7.00) and T2 (7.00) than for T3 (6.83) and T4 (6.84). We conclude that hauling catfish at 10°C and/or chilling carcasses prior to filleting could improve fillet quality. Cost/benefits of transport at 10°C or chilling carcasses before filleting need to be determined.

Key Words: catfish, fillet quality, transport

1812 Effects of pre-slaughter holding time on dressing-out percent and meat quality for bulls and steers. R. W. Purchas*, D. L. Burnham, and S. T. Morris, *Massey University, Palmerston North, New Zealand*.

Carcass and meat quality characteristics were compared for Angus and Angus-cross bulls ($n=58$) and steers ($n=59$) held at the meat plant for either 4h ($n=59$) or 28h ($n=58$) before slaughter. All cattle had been finished on pasture and the fasting time prior to arrival at the plant was c. 2h. At the plant cattle had access to water but not feed. Losses in live weight from farm to the time of slaughter were more than twice as high for the 28h group (46.8 vs 21.6 kg; $P < 0.001$), and the weight-adjusted dressing-out percent values based on on-farm weights were significantly lower for the 28h group (50.73 vs 51.99 ; $P < 0.001$). This indicated that the increased holding time led to a carcass weight loss that corresponded to 6.9 kg for an animal that weighed 550 kg on the farm. The extent of weight loss was similar for bulls and steers. Carcass composition and shape traits were unaffected by holding time. Meat quality was assessed on samples of longissimus thoracis muscle between ribs 6 and 12. Ultimate pH (pH_{ult}) was higher for the 28h group than the 4h group for the bulls (5.75 vs 5.57 ; $P < 0.05$) but not the steers (5.47 vs 5.46). Measures of sensory tenderness did not differ between the two holding-time groups either before or after adjustment for pH_{ult}, even though pH_{ult} had a significant effect on all measures of meat tenderness. Objective measures of tenderness by Warner-Bratzler shear or by MIRINZ tenderometer also did not differ between the two holding-time groups either with or without pH adjustment. Sensory juiciness scores were unaffected by holding time, but pH-adjusted cooking losses and expressed-juice values were lower for meat from the 28h-hold group suggesting some muscle dehydration. Increasing the holding time for cattle at the meat plant from 4 to 28 hours is likely to lead to carcass weight losses, but effects on meat quality are likely to be minimal provided high-pH beef is avoided.

Key Words: Beef Quality, Dressing-out Percent, Holding Time

1813 Instrumental and chemical characteristics, calpastatin mRNA genic expression and myofibrillar protein concentration in chilled meat of feedlot Brazilian Superyoung cattle *Bos taurus* × *Bos indicus* 24h postmortem. L. A. L. Chardulo*¹, J. A. Ferro², A. C. Silveira¹, L. R. Furlan¹, M. D. B. Arrigoni¹, H. N. Oliveira¹, M. I. T. Ferro², and C. Ludovico¹, ¹UNESP - Botucatu, SP/Brazil, ²UNESP - Jaboticabal, SP/Brazil.

Two hundred male and female crossbred animals were used. These were products of a cross between Aberdeen Angus, Charolais, Gelbvieh, Simmental and Hereford males and 1/2 Simmental × 1/2 Nellore crossbred females, weaned by creep-feeding method and kept in feedlots afterwards. The animals were slaughtered when weighed more than 440 kg (males) and 400 kg (females). One-gram samples of the Semitendinosus were collected for calpastatin mRNA expression analysis by dot blot and myofibrillar protein quantification by SDS-PAGE. Samples of the longissimus were collected between the 12th and 13th ribs for chemical and instrumental analysis of the meat. Experimental design was completely randomized. In chemical and compositional analysis of the meat, the Aberdeen Angus animals had higher subcutaneous and intramuscular fat ($p < .01$), as well as lower pH, ribeye area and shearing force ($p < .01$). Internal meat temperature 15h postmortem was higher for Aberdeen Angus animals ($p < .05$). Female showed higher fat deposition on the meat, pH and temperature ($p < .01$) but lower ribeye area ($p < .01$). No differences ($p > .05$) were observed for color characteristics, protein, humidity and losses during cooking for the different genetic groups, ages and sexes. There was also no differences ($p < .05$) in the quantity of calpastatin mRNA between the different breeds and sexes, although, Aberdeen Angus animals had lower myofibrillar protein levels ($p < .01$), denoting a higher postmortem proteolysis rate. The ability of Aberdeen Angus breed in producing tender meat in the Brazilian Superyoung System may be related to a higher fat deposition in carcass and meat, what consequently gives a better protection against the rapid cooling procedure studied herein.

Key Words: Young crossbred cattle, Calpastatin, Myofibrillar proteins

1814 Abundance and cellular distribution of the calpain proteolytic system proteins in the Longissimus of the ovine. R. Bickerstaffe*¹, M. Ilian¹, and H. Sorimachi², ¹Lincoln University, ²The University of Tokyo.

The calpain proteolytic system in mammalian skeletal muscle is a family of Ca²⁺-activated neutral thiol endopeptidases classified as ubiquitous (calpains 1 and 2) and tissue-specific (calpain 3 or p94). Calpains 1 and 2 are composed of 80 kDa catalytic subunits, which are products of separate genes, and a 30-kDa regulatory subunit, which is identical in both enzymes. The structure of calpain 3 differs from calpains 1 and 2 in the presence of 3 unique regions that are expected to convey functional specificity, and in the absence of the small subunit. Another distinguishing feature between the ubiquitous calpains and calpain 3 is that, unlike calpains 1 and 2, calpain 3 is not inhibited by calpastatin (a specific endogenous inhibitor protein). Several studies have indicated that the calpain proteolytic system plays major roles in muscle growth and development in health and disease. The challenge is that the physiological functions of the various muscle calpains remain unknown. As a step toward the elucidation of the specific function of the individual calpains in skeletal muscle we developed western assay to quantify the protein level of calpain 1, calpain 2, calpain 3 and calpastatin in ovine skeletal muscle. The method is based on constructing standard curves using predetermined amounts of pure calpain proteins. We used the above method to determine the abundance and cellular distribution of the calpain proteolytic system proteins in the longissimus (LD) of the ovine. The results (average ± SD, n = 4) revealed that the level (fmole/mg tissue) of calpain 1, 2, 3 and calpastatin in the LD was 309 ± 106, 846 ± 108, 4180 ± 322, and 487 ± 56, respectively. Cellular distribution of the calpains in the LD indicated that calpain 2 and calpastatin are present in the sarcoplasmic fraction but not in the myofibrillar fraction. However, calpains 1 and 3 are present in the sarcoplasm and at the myofibril at 71:29 and 18:82 ratios, respectively. Based on the pattern and level of expression, we infer that the calpains are performing different functions in the LD and that calpains 1 and 3 may be involved in the metabolism of myofibrillar proteins.

Key Words: Calpain, abundance, muscle

1815 Effects of marination on the processing parameters and palatability of bison top round. J.S. Dhanda*¹, R.B. Pegg¹, J.A.M. Janz², J.L. Aalhus³, and P.J. Shand¹, ¹University of Saskatchewan, Saskatoon, SK, Canada, ²University of Alberta, Edmonton, AB, Canada, ³Agriculture and Agri-Food Canada Research Centre, Lacombe, AB, Canada.

Injection of phosphate and salt containing marinades increases the palatability of a wide variety of meat products, but many of these studies have been based on domestic livestock species. The present study was conducted to investigate the effects of marination on the palatability of bison top round steaks/roasts cooked by two cooking methods (dry or moist-heat) and to two endpoint temperatures (71°C or 77°C). Twenty paired *semimembranosus* muscles were obtained from 10 male bison: each of these muscles was divided longitudinally into two sections. One section was injected to 110% of its original weight to contain 0.5% sodium chloride and 0.3% sodium tripolyphosphate, while the other was kept as a non-injected control. The steaks/roasts obtained from control and injected sides were used for color appraisal, tenderness evaluation and consumer acceptance studies. Bison steaks (stored at 31°C and under 975 Lux) held a bright red color for 2 days, but after that discoloration became evident. HunterLab a* (redness) values did not change significantly between treatments; however, injected steaks had lower L* (lightness) and b* (yellowness) values ($P < 0.01$) compared to control steaks. Cook yields for the steaks/roasts from the injected sections were significantly higher compared to those from control non-injected sections when cooked to either 71°C or 77°C. Injected steaks/roasts had significantly lower shear force values (63.9N) compared to controls (102.3N). Bison samples cooked by moist-heat (water bath) had significantly lower cooking losses and shear values compared to those cooked by dry-heat (oven broiling). As expected steaks/roasts were more tender and had better cook yields when processed to a lower temperature (71°C) compared to an internal temperature of 77°C. A panel of 80 consumers revealed that injected steaks had better acceptance in terms of tenderness, juiciness and flavor compared to non-injected ones. The findings of the present study suggest that marination by injection has a great deal of potential in improving the palatability of lesser value cuts of bison.

Key Words: Marination, Palatability, Bison top rounds

1816 Antihypertensive activities of enzymatic hydrolysates of porcine skeletal muscle proteins. Y Nakashima*, K Arihara, S Ishikawa, and M Itoh, *Kitasato University, Towada-shi, Japan.*

Inhibitors of angiotensin I-converting enzyme (ACE) have been shown to have antihypertensive activities and have been utilized for pharmaceuticals and physiologically functional foods. Several ACE inhibitory peptides, which have the antihypertensive activity, have been found in the enzymatic hydrolysates of foodstuffs, such as milk proteins. However, little is still known about the derivation of ACE-inhibitory and antihypertensive activities from meat proteins. The objective of this study was to investigate these activities of the enzymatic hydrolysates of porcine skeletal muscle proteins. Porcine skeletal muscle myosin was hydrolyzed by one of eight kinds of proteases. Among these hydrolysates, thermolysin digests showed the highest ACE inhibitory activity. The single oral administration of thermolysin digest of myosin to spontaneously hypertensive rats (SHR) significantly decreased their systolic blood pressure. Two ACE inhibitory peptides, named myopentapeptides A and B, Met-Asn-Pro-Pro-Lys and Ile-Thr-Thr-Asn-Pro, were purified from thermolysin hydrolysate of myosin by HPLC with reversed phase mode. Of the synthesized two myopentapeptides and six tripeptides, which have parts of the sequences of myopentapeptides, four peptides (myopentapeptides A and B, Met-Asn-Pro, Pro-Pro-Lys) demonstrated antihypertensive activities by their single oral administration in SHR significantly. Porcine skeletal muscle actomyosin and its thermolysin hydrolysate were tested for the activity of preventing hypertension by their long-term oral administration in SHR. The antihypertensive activity was demonstrated by the administration of thermolysin digest. This study demonstrated that ACE-inhibitory and antihypertensive activities can be generated from meat proteins by enzymatic hydrolysis. Utilization of enzymatic hydrolysates of meat proteins and corresponding peptides could lead to the development of new healthy meat products.

Key Words: Antihypertensive activity, Skeletal muscle proteins, Peptide

1817 Oxidative differentiation in muscle of small and large pig fetuses in late gestation. C. Ashton* and N. Stickland, *The Royal Veterinary College, London, UK, NW1 0TU.*

Muscle tissue consists of muscle fibres, which form in a biphasic manner. Initially, a myoblast population fuses to generate primary fibres, providing a surface on which a second population of myoblasts fuse to form secondary fibres. Secondaries are first observed at about 54 days in the pig. In the pig, muscle fibre hyperplasia is completed by about day 90 of gestation. The adult pig semitendinosus muscle is composed of a deep (oxidative rich) and a superficial (less oxidative) area. Prenatal differentiation in terms of contraction speed has been identified. However, oxidative (metabolic) differentiation has not been shown prenatally. The semitendinosus muscles from 11 pairs of the smallest and largest pig fetuses at 80-100 days gestation were removed. Succinic dehydrogenase (SDH) staining was performed on complete frozen transverse sections. Optical density measurements were recorded over the entire section from the most superficial to the deepest border. Although, there was no significant difference ($P > 0.05$) between the muscles of littermates, a significant difference ($P < 0.01$) between the superficial and deep portion of the muscle was observed. The results suggest that oxidative muscle differentiation does occur before birth. In fact the results imply that oxidative differentiation is occurring as early as day 80, prenatally. Both the deep (mean OD for small and large piglets = 190.188) and superficial (mean OD for small and large piglets = 193.945) portions of muscle were still very oxidative at this stage. However, the results have shown that some significant differentiation was occurring, within individual semitendinosus muscles, but not between littermates.

Key Words: Oxidative differentiation, Muscle, Prenatal

1818 Omega-3 fatty acids and meat lamb quality. F. Nicastro*¹, L. Zezza¹, and R. Gallo, *Department of Animal production, University of Bari, Bari, Italy.*

Nowadays meat is often seen as one of the factors that are responsible for a negative, unhealthy lipidic contribution. The composition of fatty acids in animals largely depends on the type of diet, especially the quality of dietary fat. We must use the omega-3 fatty acids for a more protective and healthier diet, to grant them the completion and physiological control of several functions of the organism. Twenty 30 d old Delle Langhe bred wether lambs were divided into two groups of 10 and housed indoors for eight weeks. The two groups received hay ad libitum and the first group was fed a basal diet of commercial concentrate (Control), while the second group received a diet supplemented with 3% fish oil (Omega 3). At the end of feeding, the lambs were fasted overnight and slaughtered. Hot carcass weight was measured at 45 minutes post mortem and carcasses chilled overnight. The right sides of the carcasses were weighted and cut into wholesale cuts. The weights were expressed as a percent of the cold carcass weight. The loin and leg cuts were separated in lean, bone and fat. Samples for meat quality investigations were removed from the longissimus thoracis for meat color and shear measurements. Meat color was taken using CIE methods (L, a, b) and the shear force was measured from the LT muscle raw and cooked. Objective measurements showed a significant ($P < .05$) increase in redness (a), in lambs fed fish oil whereas the control group was much lighter (L), than the group fed omega-3. The raw and cooked muscle of the lambs fed with omega-3 had significant ($P < .01$) effect on shear force (2.95 and 2.85 kg core for raw and cooked muscle respectively), so the loin tenderness was positively affected. In the leg the percentage of lean decreased with the omega-3, whereas fat markedly increased ($P < .05$). Lean and fat percentages of the loin are also influenced by the lamb's feeding, but with an opposite trend. In fact the lean goes up from 48.15 to 52.63% ($P < .05$), whereas the fat decreased. The omega-3 fatty acids, in the amount used in this study, have little influence in the cuts of carcasses.

Key Words: Lamb, Diet, Meat quality

1819 In Ovo Manipulation of Posthatch Growth in the Turkey. A. R. Somaiya* and N. C. Stickland, *Royal Veterinary College, London, UK.*

In fish, temperature has been successfully used to alter muscle tissue characteristics and postnatal growth. The main aim of these studies was to quantify the difference in muscle tissue parameters in turkey poults from eggs incubated at different temperatures, both higher and lower

than the optimum 37.5°C. Control eggs were set at 37.5°C for the duration of the 28 day incubation period. The time periods chosen to apply the experimental temperatures (38.5°C and 35.5°C) were for periods of four days, either 0-4, 5-8, 9-12, 13-16, 17-20, 21-24 and 25-28 days of incubation. Semitendinosus (ST) and pectoral muscles were taken and transverse sections were cut from the whole ST and a 1cm² sample of pectoral muscle at 16 days posthatch. The muscles were sectioned and stained to determine ST muscle area, total nuclei and fibre number and pectoral nuclei and fibre number densities. It was found that application of the lower temperature at the beginning of the incubation period (days 5-8) produced a decrease ($P < 0.05$) in ST weight (.50 vs .65), a decrease ($P < 0.05$) in total nuclei number per section (69,000 vs 76,500), but an increase ($P < 0.05$) in the total number of fibres (130,000 vs 110,000), compared to control. Conversely, application of the higher temperature during the same time period produced an increase ($P < 0.05$) in ST total nuclei number per section (100,000 vs 76,500), a decrease ($P < 0.05$) in total fibre number (90,000 vs 110,000), but also a decrease ($P < 0.05$) in ST weight (.50 vs .65), compared to control. These results suggest that even within the same strain there are different mechanisms of growth that can be employed, depending on the growth conditions available. Application of 35.5°C produced a relatively more hyperplastic growth (increase in fibre number), while 38.5°C a more hypertrophic growth (increase in fibre cross-sectional area). From studies on other species, it is known that a greater fibre number is often associated with better growth, greater feed conversion efficiency, leaner meat and also better meat quality. These results could therefore have implications for these parameters in turkeys.

Key Words: Fibre number, Meat quality, Posthatch growth

1820 Effect of supplemental fat on growth performance and quality of beef from steers fed barley-potato product finishing diets II. Beef appearance, shelf-life, and palatability. D. J. Marks, J. R. Busboom*, M. L. Nelson, J. D. Cronrath, L. Falen, and P. S. Kuber, *Washington State University.*

The objective of this study was to evaluate the effects of supplemental fat in finishing diets on moisture properties, shelf life measurements, and palatability of beef. One hundred sixty-eight crossbred steers (318 2.8 kg) were allotted within weight block (3) to a randomized complete block design with a 2 x 3 + 1 factorial arrangement of dietary treatments. Main effects were level of yellow grease (0, 3, and 6%), and level of alfalfa hay (3.5 and 7%) with the added treatment of 6% tallow and 7% alfalfa hay in barley-based diets containing 15% potato by-product and 7% supplement fed for 165 d. Longissimus muscle cuts from four randomly selected steers per pen were used for determination of moisture retention properties, L*, a*, and b* color values using a Hunter Miniscan[®], evaluation by a four person retail shelf-life panel and an eight member trained sensory panel (10 cm line scale). Diet did not affect ($P > 0.1$) pH (5.57 0.1) and wholesale purge (.5 0.1%). Shelf life measurements of color score, retail purge score, and L*, a* and b* values decreased with day ($P < 0.01$) with no dietary effects ($P > 0.1$). Diet did not affect drip (3 0.1%) or cook loss (28.8 2.5%). Initial tenderness was increased quadratically ($P < 0.10$) with yellow grease from 7.2 to 7.6 to 7.4 0.1, and decreased ($P < 0.10$) with alfalfa level in evaluation by the trained sensory panel. Diet did not affect initial juiciness (6.9 0.1), sustained juiciness (5.6 0.2), or beef flavor (5.3 0.1). There was an interaction of yellow grease by alfalfa detected for off flavor ($P < 0.05$), however all scores were less than 0.5 and were probably not biologically important. Supplemental fat did not affect most measurements of beef quality and palatability. However, supplemental fat increased initial tenderness for the sensory panel.

Key Words: Barley, Yellow Grease, Beef Palatability

1821 Effect of supplemental fat on growth performance and quality of beef from steers fed barley-potato product finishing diets III. Fatty acid composition of muscle and subcutaneous fat. D. J. Marks*, M. L. Nelson, J. R. Busboom, J. D. Cronrath, A. E. Koepp, and L. Falen, *Washington State University.*

One hundred sixty-eight crossbred steers (318 2.8 kg) were used to evaluate the effects of supplemental fat in finishing diets on fatty acid composition, including the c9,t11 isomer of conjugated linoleic acid (CLA) of longissimus muscle (LM) and subcutaneous fat. Animals were allotted within weight block (3) to a randomized complete block design with a 2

x 3 + 1 factorial arrangement of dietary treatments. Main effects were level of yellow grease (YG; 0, 3, and 6%), and level of alfalfa hay (3.5 and 7%) with the added treatment of 6% tallow (T) and 7% alfalfa hay in barley-based diets containing 15% potato by-product and 7% supplement fed for 165d. Fatty acids of LM and subcutaneous fat from four randomly selected steers per pen were quantified using gas chromatography after methylation with sodium methoxide. Dietary treatment did not affect total fatty acid (FA) content (DM basis) of LM (143 4.5 mg/g) or fat (958 9.3 mg/g). Palmitic acid decreased linearly ($P < 0.001$) with YG from 29.5 to 27.8 0.31 g/100g FA in fat. Stearic acid linearly increased ($P < 0.05$) with YG from 11.4 to 12.9 0.26 and from 10.0 to 12.0 0.34 g/100g FA in LM and fat, respectively, and oleic acid in fat from 42.1 to 43.5 0.44 g/100g FA. Steers fed 6% yellow grease compared to T had less ($P < 0.05$) stearic acid in LM (12.7 and 13.9 0.37 g/100g FA) and more oleic acid in fat (43.0 vs. 40.9 0.62 g/100g FA) and LM (42.7 vs. 40.3 0.53 g/100g FA). Level of yellow grease increased CLA quadratically ($P < 0.01$) in LM from 0.45 to 0.64 to 0.62 0.02 g/100g FA and fat from 0.61 to 0.835 to 0.825 0.02 g/100g FA. Conjugated linoleic acid was higher ($P < 0.1$) in LM (0.62 vs. 0.54 0.04 g/100g FA) and also higher ($P < 0.05$) in fat (0.81 vs. 0.69 0.04 g/100g FA) from steers fed yellow grease compared to T diets. Content of CLA in beef was increased without increasing total FA content by feeding yellow grease.

Key Words: Barley, Yellow Grease, CLA

1822 Market orientation: A possibility to improve consumers' acceptability of pork products. Charlotte Prestat* and M. Susan Brewer, *University of Illinois, Urbana-Champaign, IL.*

Pork producers have been confronted with increasing competition over the past few years, resulting in a renewed interest in developing food products with greater value added. However, since consumers are relatively closed to innovation, there is limited room for new product development. Understanding factors associated with purchase and consumption of pork will facilitate development of products and processes that promote pork utilization and increase market share. In this study, factors that may affect pork acceptability were evaluated by analyzing purchase and consumption behavior, as well as quality perception. A consumer survey ($n=200$) was conducted to qualitatively and quantitatively model the consumer choice process, to assess to what extent selected product characteristics impact consumers' quality evaluation and purchase intent, and to assess their weight relative to each other. Data were subjected to cluster analysis. Three clusters were separated. Cluster 1, representing 8.2% of the respondents, was primarily female (62.5%), over 40 years of age (68.8%). This group was concerned about health issues. The amount of visible fat accounted for 39% of the purchase decision while consumption acceptability depended essentially on the amount of fat in/on the product (51.5%). The second cluster (35.4% of the respondents) was primarily female (60.9%), between the ages of 18 and 40 (62.3%). The color (30%) and the amount of visible fat (21.5%) seemed to influence purchase intent for this cluster. Flavor and degree of doneness were equally important (27%) with respect to consumption acceptability. The third cluster (56.4% of the respondents) was primarily male (54.5%) between the ages of 18 and 55 (90%). Price was the most important factor (32%) during purchase, while sensory characteristics appeared to determine the experienced quality (flavor, 27.5%; tenderness, 22%; and juiciness, 18%). As the third cluster represents the majority of the respondents, particular attention should be paid to their behavior. These results suggest that enhancement of the sensory attributes of pork products along with a reduction of costs should be the priority of the pork industry.

Key Words: Pork product, Marketing Orientation, Consumer Purchase and Consumption Behavior

1823 Combined effects of pH and temperature on myoglobin in a model system. Liugen Zhu* and Susan Brewer, *University of Illinois at Urbana-Champaign.*

To understand the basic mechanism of the PSE phenomenon with respect to color abnormalities, the contributions of sarcoplasmic and myofibrillar protein denaturation under the combined influences of high temperature and low pH is of utmost importance. From a series of experiments heating metmyoglobin solutions at pH 5.0, 5.3, 5.6, 6.0, 6.5 and 7.0, the effects of temperature and pH on thermal stability of metmyoglobin were investigated. The percentage metmyoglobin denatured

at temperatures from 25 to 80°C was determined. pHs lower than 6.5 caused metmyoglobin denaturation at various temperatures from 25 to 80°C, but was particularly apparent when pH < 5.6. Metmyoglobin denaturation did not occur until 60°C at pHs from 5.3 to 7.0. It occurred at 55°C at pH 5. Thermal stability of metmyoglobin increased as pH increased. A slow heating rate (0.9°C/min) caused more thermal metmyoglobin denaturation than a fast heating rate (1.3°C/min) when the temperature was above 55 to 60°C. The denaturation caused by low pH alone was reversible, while that caused by high temperature was not.

Key Words: myoglobin, PSE pork, protein denaturation

1824 Development of photographing equipment for the cross section of carcass and prediction of Beef Color Standard number by using obtained image from that equipment. K. Kuchida*, M. Hasegawa, M. Suzuki, and S. Miyoshi, *Obihiro University of AVM, Obihiro-shi Japan.*

The first aim of this study was to develop photographing equipment, which is able to take a clear image of the cross section of carcass integrating the digital camera and the illumination device. The second aim was to predict the Japanese Beef Color Standard (BCS) number by using the obtained image from that equipment. BCS is the standard model and consists of 7 ranks for the shade of meat color. The photographing equipment was composed of a dome section, the ring illumination section, and a digital camera section. 570 white LEDs (Light Emitting Diode) were arranged upward at the bottom of the dome section like a ring, and 432 white LEDs were arranged in a downward direction on the ring illumination section. The bottom of the dome section contacted with the cross section of carcass, so that photographing from a perpendicular direction and a constant distance was possible. Images around the ribeye at 6th-7th rib cross-section were collected ($n=1,208$) at a meat processing plant in Hokkaido, Japan. BCS number assigned by grader was predicted by multiple regression analysis using image analysis traits. Digital images of 1,208 carcasses were taken by this equipment. As no sample with diffused reflection existed on the surface of the ribeye, clear and stable images were effectively taken by using this equipment. The correlation coefficients of R, G, B components and luminance from image with BCS number of the standard model of BCS were -0.98, -0.91, -0.82, and -0.99, respectively. These results indicated that the relationship between luminance and BCS number of standard model had highly linearity. However, the correlation coefficients between luminance and BCS number of actual carcass ($n=1,208$) were lower ($r=-0.66$) than that of the BCS standard model. Multiple regression equation with the BCS number assigned by grader as the dependent variable were obtained by a stepwise method starting with 108 independent covariates for image analysis traits. BCS number was predicted by using the multiple regression with five covariates selected by the stepwise method. The percentages of the difference between the assigned BMS and the predicted BMS being ± 0 and within ± 1 were 76.8% and 100.0%, respectively.

Key Words: Meat color, Digital image, Image analysis

1825 Effect of high oil corn and vitamin E supplementation on ground beef case-life properties. M.S. Eibs*, B.J. Johnson, D.M. Wulf, B.C. Shanks, and T.A. Wittig, *South Dakota State University.*

The objective of this experiment was to investigate the effects of high oil corn and vitamin E supplementation on ground beef case-life properties. Steers ($n = 84$) were fed a high concentrate diet consisting of either typical corn (C: 79.5% of ration) or high oil corn (HOC: 79.5% of ration) for 112 days with (+E) or without (-E) vitamin E supplementation during the last 50 d (1,000 IU/hd/d). Steaks were removed 24 h post-mortem from the 12th rib and trimmed. Steak trimmings were ground and formed into patties for retail display panel (RDP), thiobarbituric reactive substances determination (TBARS), and tocopherol analysis. Two storage treatments were used prior to RDP: 1) domestic chilled (DC), chilled storage for 13 d postmortem; and 2) export chilled (EC) chilled storage for 34 d postmortem. Patties were monitored for 9 d (d 0 to 8) under simulated retail meat display conditions by a 5-member panel and color was measured with a Minolta colorimeter. On d 8, TBARS of RDP samples were quantified. HOC grain contained greater ($P < 0.05$) α - and γ -tocopherol levels than C grain (14.62 and 84.90 vs 8.01 and 41.68 ppm). Ground beef concentrations of α - and γ -tocopherol were higher ($P < 0.05$) in HOC+E as compared to HOC-E, C+E, and C-E. Rate of discoloration, as appraised by RDP, was slower ($P < 0.05$)

for patties from HOC+E as compared to HOC-E, C+E, and C-E for EC storage treatment. Export chilled HOC+E patties maintained higher ($P < 0.05$) a* values from d 2 to 8 when compared to HOC-E, C+E, and C-E. Patties from DC storage treatment with +E had lower ($P < 0.01$) TBARS than -E patties. For EC ground beef, the reduction in TBARS for HOC+E vs HOC-E was twice the magnitude of the TBARS reduction for C+E vs C-E (corn type by vitamin E interaction, $P < 0.05$), indicating +E had greater effects on TBARS for HOC fed cattle than for C fed cattle. These data suggest that the supplementation of vitamin E while feeding high oil corn to finishing beef steers elevates tocopherol levels in ground beef and slows the rate of discoloration.

Key Words: High Oil Corn, Tocopherol, Ground Beef

1826 Increased calcineurin activity is associated with muscle hypertrophy in callipyge sheep. C. E. Carpenter* and N. E. Cockett, *Utah State University.*

Calcineurin (Cn; protein phosphatase 2B) is a calcium-activated phosphatase that provides central downstream signals regulating muscle growth and development. Presently, Cn is understood to play a central role in muscle hypertrophy and expansion of the slow fiber population in chronically overloaded muscle. It is known that muscle hypertrophy and increased predominance of fast fibers occur in the longissimus, but not the supraspinatus, of callipyge sheep after they reach about 5 weeks of age. We tested whether altered Cn activity accompanied these effects. Calcineurin activity was determined in muscle extracts of the hypertrophy-responsive longissimus dorsi (LD) and hypertrophy-nonresponsive supraspinatus (SS) from 2-week-old and 8-week-old lambs of the callipyge and normal genotype. Muscle type, age, and genotype had an interactive effect ($P < 0.05$) on Cn activity suggesting that the callipyge gene exerts its effects in muscle via Cn-mediated pathways. Calcineurin activity was greater ($P < 0.06$) in the hypertrophy responsive LD from 8-wk-old callipyge (1.6×10^{-3} units activity per gram protein) as compared to 8-wk-old normal lambs (1.2×10^{-3}) or 2-wk-old callipyge lambs (1.3×10^{-3}). There were no differences for similar comparisons of Cn activity in extracts of SS. These observations suggest an active role of Cn in mediating the hypertrophy and shift towards the fast phenotype that occurs in the LD of callipyge lambs. The callipyge model of muscle hypertrophy may provide a unique model to study Cn-mediated signaling in skeletal muscle.

Key Words: Callipyge, Calcineurin, Skeletal muscle

1827 Diets containing conventional corn, conventional corn and choice white grease, high oil corn, or high oleic, high oil corn will influence the fatty acid profile of fresh pork adipose tissue. C. A. Stahl*¹, M. L. Linville¹, K. R. Maddock¹, T. E. Sauber², G.L. Allee¹, and E. P. Berg¹, ¹*University of Missouri, Columbia, MO, 2*²*DuPont Specialty Grains, Des Moines, IA.*

The objective of this study was to evaluate the effect of corn type on the fatty acid profile of six distinct fat depots within the pork carcass. Gene Packer X EB barrows ($n = 196$, 26.6 kg) were blocked by weight and randomly allotted 28 pens (7 replications per pen). Each treatment group had ad libitum access to one of four corn-based diets consisting of conventional corn (CONV), conventional corn supplemented with choice white grease (CWG), high oil corn (HOC) or high oleic, high oil corn (HOHOC). Following 98d on test, two animals per pen ($n = 56$) representing the average pen weight (118 kg) were selected for harvest. A single slice (cranial) of the fresh belly, belly leaf fat, ham seam (star) fat, ham inner and outer subcutaneous (s.c.) fat layers, and loin inner and outer s.c. fat layers were collected at 24h postmortem. Individual samples were packaged and frozen for subsequent fatty acid profile analysis. The saturated fatty acids palmitic (C16:0) and stearic (C18:0) were higher ($P < .05$) in the CONV treatment. Furthermore, the CONV treatment possessed the lowest percentage of unsaturated fat in all six fat depots ($P < .05$). CWG exhibited the highest percentage ($P < .05$) of conjugated linoleic acid in fresh belly slices, belly leaf fat, ham seam and inner s.c. fats, and loin inner s.c. fat. HOC treated animals possessed the highest percentage ($P < .05$) of linoleic (C18:2cis) acid. Total unsaturated and polyunsaturated fatty acids expressed as a percent of total lipid were highest ($P < .05$) in the HOC treatment. Differences ($P < .05$) were found in the percentage of monounsaturated fatty acids within the HOHOC diet, with the concentration of oleic (C18:1cis) acid

greatest ($P < .05$) in all six fat depots. In conclusion, the level of saturated and unsaturated fatty acids within corn-based diets significantly affects the fatty acid profile of fresh pork adipose tissue.

Key Words: fatty acid, oleic acid, pork

1828 Genetic line effects on palatability, color and physical characteristics of fresh pork loin chops. J. M. Schlickau*¹, M. S. Brewer¹, A. Sosnicki², B. Field², and F.K. McKeith¹, ¹*University of Illinois, 2**PIC.*

The objective of this study was to characterize the sensory attributes, color and physical characteristics of pork from pigs of the following backgrounds: Duroc, Pietrain (Halothane negative, NN), Pietrain (Halothane positive, nn), Berkshire, Hampshire (rn), Hampshire (RN-), and a synthetic line. A trained panel evaluated visual appearance of uncooked lean and fat, and flavor and texture of cooked chops. L*, a*, and b* values, hue angle, cookloss and Warner-Bratzler shear force also were determined. Chops from Hampshire rn carcasses appeared more pink than those from Hampshire RN- carcasses. Chops from Duroc, Berkshire, Pietrain-nn, and the synthetic line had the lowest pink color intensity and were a minimum of 4 scale units lower than chops from Hampshire-rn carcasses. Chops from Berkshire carcasses appeared most marbled in the lean followed by those from Hampshires; chops from the synthetic line and from Pietrain-nn pigs appeared least marbled. Chops from Pietrain-nn and Hampshire-rn carcasses had the highest a* values; chops from Duroc, Pietrain-NN, and Hampshire-RN- carcasses had the lowest. Cook loss from chops from Duroc carcasses was lower than that from Hampshire, Pietrain-NN and synthetic line carcasses. The total cook loss range was 2.5% which could have significant economic implications. Warner-Bratzler shear force was highest for chops from Pietrain-nn and Hampshire-rn carcasses. Chops from Hampshire-RN- carcasses were most juicy followed by those from Hampshire-rn, Pietrain-NN, Berkshire and Duroc carcasses. Warner-Bratzler shear force was positively correlated with abnormal flavor intensity, metallic taste, and chewiness ($r = 0.72, 0.94, \text{ and } 0.69$, respectively), and negatively correlated with sweetness ($r = -0.73$). As shear force increased, off flavors, metallic flavors and chewiness increased while sweetness decreased suggesting that genetic background may have some indirect impact on flavor. Overall, genetic background had significant effects on many of the quality characteristics evaluated, however, no one genetic background resulted in high scores in all, or even most, traits. This indicates that different genetic lines have different quality attributes to contribute.

Key Words: genetic lines, cook loss, color

1829 Effect of enhancement of beef rounds on sensory and retail display characteristics. K.L. Robbins* and M.S. Brewer, *University of Illinois, Urbana-Champaign, IL.*

Beef round roasts from USDA Choice and Select beef carcasses were used to evaluate the potential for enhancing sensory and retail display characteristics by injecting a solution of sodium chloride and phosphate. Paired sides were fabricated and the semimembranosus was removed from each side. The right and left sides were randomly assigned to control or injected treatments (0.4% sodium chloride 0.4% phosphate solution pumped to 110% raw weight). Muscles were pumped at day 14 - 21 postmortem. Following equilibration (5 - 10 d), steaks from each section were sliced to 2.5 cm and used for either sensory evaluation or overwrapped and displayed in a coffin style display case at 4C for up to 6 days. Samples for sensory evaluation and Warner Bratzler shear were cooked to 72C in electric skillets. Data were analyzed using a paired-T procedure. The trained panel determined that the enhanced steaks were significantly ($P < 0.05$) more juicy and salty than the control steaks; however, tenderness and Warner Bratzler shear values did not differ. Enhancement had a detrimental effect on the color scores of the round steaks over display time. After two days in display, the enhanced steaks had significantly ($P < 0.05$) lower visual color scores indicating darkening and discoloration. By day 4, a* and b* values were significantly lower for the enhanced steaks indicating they were less red and yellow. The aerobic plate counts (APC) suggested that enhanced steaks were slightly more susceptible to microbiological growth during retail display; however, the difference was not significant. Further work is continuing to evaluate enhancement of lower quality grades of beef at

various times postmortem to improve sensory and retail display characteristics and to increase beef consistency and consumer acceptability.

Key Words: Beef, Enhancement, shelf life

1830 Effect of breed-type on the performance and carcass traits of hair-sheep. J. K. Apple¹, J. M. Burke², W. J. Roberts¹, J. S. Stephenson¹, and L. K. Rakes¹, ¹University of Arkansas, ²USDA-ARS Small Farms Research Center, Booneville, AR.

Live animal performance and carcass characteristics were measured for purebred Katahdin (K; n=15) and St. Croix (SC; n=8) lambs, as well as three-quarter St. Croix (SCX; n=8), Dorper × Romanov × St. Croix (DX; n=9), and Dorper × St. Croix (DXSC; n=7) lambs. After weaning, lambs were allowed 4 weeks to acclimate to a high concentrate finishing diet, which was fed for 120 to 127 d. Lambs were then transported to the University of Arkansas Red Meat Abattoir for harvest. At harvest, K, SC, SCX, DX and DXSC weighed 44.8, 43.7, 42.8, 49.6 and 56.4 kg, respectively. Carcass quality and cutability data were collected after a 7-d aging period at 2 C. From birth to weaning, K and DXSC lambs had higher (P<0.01) ADG than SC and SCX lambs; however, from weaning to harvest, DXSC had the highest (P<0.01) ADG, followed by DX, SC, SCX and K (253.7, 226.1, 204.9, 193.1 and 181.1 g/d, respectively). Carcasses from DXSC lambs were heavier (P<0.01) than all other breed-types; whereas, carcasses from K, SCX, DXSC and DX had greater (P<0.01) actual and adjusted fat thickness measurements, and resulting yield grades, than SC. Although fatter, carcasses from DXSC lambs had the largest (P<0.01), and SC and SCX lambs the smallest (P<0.01) longissimus muscle (LM) areas. Although kidney fat weights were similar (P>0.72), carcasses from SCX lambs tended (P<0.08) to have a higher percentage of internal fat than DX, DXSC and K lambs. Skeletal, lean and overall maturities were not different (P>0.26) among the breed-types; conversely, carcasses from SC lambs had lower (P<0.05) flank streaking scores than SCX, DXSC and K, with DX carcasses receiving intermediate scores. Conformation scores for DX and DXSC carcasses were substantially higher (P<0.01), resulting in higher (P<0.01) quality grades, than SC and SCX carcasses. Although L* values of the LM were similar (P>0.84), the LM from DX lambs was redder (P<0.01) and more yellow (P<0.01) than SC and DXSC. Results from this study indicate that improvements in ADG and carcass muscularity and quality can be achieved by using Dorper sires on purebred and crossbred St. Croix dams.

Key Words: Hair-sheep, Carcass quality, Cutability

1831 Relationship between porcine longissimus dorsi pH decline and μ -calpain activity/autolysis and protein degradation. L.J. Rowe, S.M. Lonergan, M.F. Rothschild, and E. Huff-Lonergan*, Iowa State University, Ames, IA.

Degradation of muscle proteins by μ -calpain has been hypothesized to affect meat tenderness and water-holding capacity. The rate and extent of pH decline in postmortem (PM) muscle tissue may affect μ -calpain activity and subsequently the rate and extent of muscle protein degradation. The objective of this study was to determine the relationship between PM muscle pH decline, μ -calpain autolysis and muscle protein degradation in pork. To achieve these objectives, 10 market weight pigs were harvested. The pH measures of the longissimus dorsi (LD) were taken at the last rib at 2 h and 24 h PM. Samples of the LD were taken at 2 h, 24 h, 72 h, 5 d, and 7 d PM. The LD samples were extracted in 5 vol of 50 mM HEPES, pH 7.6, 150 mM NaCl, 10% glycerol, 0.1% Triton X-100, 5 mM EDTA, 2 mM PMSF. After centrifugation, a portion of each supernatant was used for casein zymography to obtain a relative comparison of μ -calpain activity. The remainder of the supernatants and the pellets were used for immunoblotting with antibodies against μ -calpain 80-kDa subunit, desmin and troponin-T. Casein zymography revealed that a majority of the samples lost detectable μ -calpain activity between 24 and 72 h PM. Samples with the lowest pH at 2 h PM lost μ -calpain activity in the supernatant earlier than samples that had slower, limited pH decline. Immunoblotting of supernatants from all 2 h PM samples showed that the 80-kDa subunit of μ -calpain was intact. The 80-kDa subunit of μ -calpain was at least partially autolyzed in all samples by 24 h PM. Samples with higher pH values at 2 h and 24 h PM had the least extensive autolysis of the μ -calpain 80-kDa subunit in the supernatant 24 h PM. In all samples the 80-kDa subunit of μ -calpain was completely autolyzed by 72 h PM. Samples that had more extensive autolysis of μ -calpain at 24 h PM had earlier degradation of troponin-T

and desmin compared to samples that had less extensive autolysis of μ -calpain at 24 h PM. These data indicate that rate and extent of pH decline may affect autolysis and activity of μ -calpain.

Key Words: μ -Calpain, Pork, pH

1832 Potassium Lactate and Sodium Diacetate Affects on the Microbial, Sensory, Color and Chemical Characteristics of Vacuum-Packaged Beef Top Loin Steaks. T. A. Williams*, R. K. Miller, N. Anwar, L. M. Lucia, and G. R. Acuff, Texas A&M University, College Station, TX.

Non-meat ingredients to enhance shelf-life, visual attributes and sensory characteristics of steaks is of high interest in the beef industry. The objective of this study was to examine the effects of injected potassium lactate and sodium diacetate on shelf life, tenderness, taste and color of top loin steaks. Beef strip loins (n = 48) were assigned to eight treatments: controls (non-injected and injected with water and sodium tripolyphosphate), potassium lactate (1.5, 2.0, and 2.5%), sodium diacetate (0.1%), and combinations of the two (1.5 /0.1 and 2.0/0.1%). After injection (110% of raw weight), top loin steaks were vacuum-packaged and evaluated for aerobic plate count (APC), Minolta color space values, trained meat descriptive attribute panel color evaluation, 2-thiobarbituric acid values (TBA), pH, purge (%), cook yield (%), Warner-Bratzler shear force (kg), and trained meat descriptive attribute sensory evaluation after 0, 7, 14, 21, 28, 35, 42, and 49 days of vacuum-package storage at 4C. Addition of sodium diacetate either alone or in combination with potassium lactate was effective in lowering APC for up to 49 days (P < 0.05). Potassium lactate increased pH (P < 0.01) and cook yield (P < 0.01), and decreased purge (P < 0.05) and shear force values (P < 0.01). Steaks injected with potassium lactate were darker (P < 0.01), but color brightened when potassium lactate was used in combination with sodium diacetate. Steaks injected with either potassium lactate and/or sodium diacetate had more two-toned color (P < 0.01) than unpackaged controls. Potassium lactate improved muscle fiber tenderness (P < 0.01), connective tissue amount (P < 0.01), and overall tenderness (P < 0.01) as determined from trained meat descriptive attribute sensory evaluation. Sensory data showed that steaks injected with potassium lactate had more soda (P < 0.01), chemical flavor aromatics (P < 0.01), salt (P < 0.05), bitter tastes (P < 0.05), and soapy aftertaste (P < 0.01) compared to controls. To increase shelf life of vacuum-packaged beef top loin steaks at 4C, 2.0% potassium lactate with 0.1% sodium diacetate is recommended; however, two-toned color and off-flavor may result.

Key Words: Beef, Potassium lactate, Sodium diacetate

1833 The influence of diets containing conventional corn, conventional corn and choice white grease, high oil corn, or high oleic, high oil corn on belly/bacon quality. G. Rentfrow*¹, K.R. Maddock¹, C.A. Stahl¹, M.L. Linville¹, T.E. Sauber², G.L. Allee¹, and E.P. Berg¹, ¹University of Missouri, ²Dupont Specialty Grains.

The objective of this study was to evaluate the effect of corn type on belly firmness and bacon slicing yields. Crossbred barrows (n=196; 26.6 kg) were given ad libitum access to one of four corn-based diets consisting of conventional corn (CONV), CONV with choice white grease (CWG), high oil corn (HOC), or high oleic, high oil corn (HOHOC). Following 98 d on test, two animals representing the average pen weight (118 kg) were selected for harvest (n=56). Bellies were removed according to IMPS 408 specifications. Lateral and vertical flex tests were performed to determine the firmness of each belly. A higher lateral and a lower vertical flex indicated a firmer belly. Bellies were weighed prior to pumping and pumped to a target of 12% retention at a commercial packing plant. After pumping, bellies were re-weighed for actual pumping percentage, and cooked according to commercial protocol. Bacon slabs were pressed then sliced by a high-speed slicer at nine slices per 2.5-cm. Incomplete slices were removed from each end and weighed for determination of slicing yield. Each slab was divided into five equal sections. The first two slices from each section were used for fracture analysis and cooking evaluation, respectively. Bacon slices were cooked on a belt cooker targeting 40% of the original weight. Weight and length were determined on each slice before and after cooking to calculate cooking loss and shrink. No differences were observed between LSMEANS

across treatment for percentage pump retention, smokehouse yield, slicing yield, or slicing fractures ($P>0.05$). Also, no differences were observed for cooking loss or length of shrink. The CONV had the lowest vertical and the highest lateral flex, while the HOC possessed the highest vertical and the lowest lateral flex. Based on the results of this study, corn type influences belly flex but does not affect pump retention, slicing yields, or slicing fractures

Key Words: Bacon, Corn-type

1834 The effect of early weaning and intensive feeding on meat quality of beef cattle. PE Strydom* and EM Buys, *Animal Nutrition and Products Institute of the Agricultural Research Council.*

Twenty crossbred steer calves selected from the Sams Tender Beef Program[®] (STB) were compared to 20 conventionally raised steers (C). STB involves weaning at three months of age (instead of seven months or more), feedlot feeding for approximately 150 days (compared to 100 days conventional). Both groups were implanted with an anabolic growth promoter, fed a commercial feedlot diet and were slaughtered at the same carcass fat condition. The *M. longissimus* (LT) and *M. semitendinosus* (eye of silverside) (ST) of both sides of the carcass were sampled and aged for either 12 or 21 days and evaluated for sensory meat quality and shear force resistance. In addition, discoloration (metmyoglobin) of steaks displayed at 4 °C for a period of 4 days were measured for loins aged for 1, 12 and 21 days (0 - 2 °C). The STB procedure had a significant effect ($P<0.05$) on tenderness related characteristics of the LT and ST at both aging periods (Table 1). The effect of the STB procedure was less for the LT than for the ST muscle. The advantage of STB was emphasized by the fact that sensory tenderness scores tended to be higher for STB meat aged for 12 days compared to C meat aged for 21 days for both muscles. Prolonged aging (21 days) tended to reduce the advantage of STB over C. Although the STB treatment tended to discolor at a faster rate during retail display than C, neither treatment nor aging period had a significant effect on color shelf life (metmyoglobin accumulation). Furthermore, both treatments had metmyoglobin levels of < 14% after 4 days; well below the threshold level for consumer discrimination of 35%.

Aging period	Sams Tender Beef		Conventional		SEM*
	12 days	21 days	12 days	21 days	
First bite tenderness†	6.40 ^{bc}	6.64 ^c	5.46 ^a	6.03 ^b	0.119
Overall tenderness	6.53 ^{bc}	6.72 ^c	5.56 ^a	6.09 ^b	0.118
Residual connective tissue	6.24 ^{bc}	6.37 ^c	5.61 ^a	5.92 ^{ab}	0.090
Shear force Resistance (Newton)	87.2 ^{bc}	78.6 ^c	106.8 ^a	92.7 ^b	2.70

^{abc} Means for each characteristic with different letters differ significantly ($P<0.05$) * Standard error of mean † Worst for score 1, best for score 8

Key Words: Beef, Tenderness, Color shelf life

1835 The effect of dietary supplemental vitamin E and C on odors and color changes in irradiated pork. S. Ohene-Adjai*, T. Bertol, Y. Hyun, M. Ellis, S. Brewer, and F. K. McKeith, *University of Illinois at Urbana-Champaign.*

Pigs (n=8/dietary treatment), were fed 4 dietary treatments: a control (CD, vitamin E- 26mg/kg feed), vitamin E (vitE-200mg/kg feed), vitamin C (vitC-500mg/kg feed), or vitamin E and C (vitEC-200 and 500mg/kg feed respectively) diet. The vitE was fed for 6 wk and vitC for 5 d. The pigs were harvested and loin (LD) and ground pork (Gr) samples were prepared in duplicates. Paired samples from the sides of individual pigs were randomly assigned to irradiation (IR) (4.5 kGy) or no irradiation (NIR) treatment to evaluate the effect of the dietary antioxidants on post-IR odor, color, and lipid oxidation. Treated LD and Gr samples were PVC-overwrapped and held in display (4°C) for 8 (Gr) and 9d (LD) to evaluate the shelf life characteristics. Color (L*, a*, and b*) and TBARS were evaluated at 0, 2, 4, and 8 for Gr and 0, 3, 6, and 9 d after overwrap for LD. Discoloration (%) of the irradiated LD was not different across dietary treatment until after 6 d. Odor intensity

worsened with irradiation. Increasing storage time resulted in darker (L*), less red (a*) samples regardless of treatment. In the LD, change in L*, a* and b* were higher in the IR than the NIR. Also, yellowness (b*) decreased over time but was generally higher in the NIR than IR. In the Gr, % discoloration and odor intensity were ($P<0.001$) higher in IR than NIR. Gr-IR was darker (L*) compared to NIR. The NIR became less red with time (a*), and IR resulted in less yellow (b*). In the ground samples TBARS were significantly higher in the IR (4.2) than in the NIR (0.9) after 2 d storage. Compared to CD-IR treatment, vitE-IR resulted in lower TBARS by 4 d. Increased TBARS occurred in vitC-IR (9.71) compared CD-IR (5.1) by 4 d. The results suggest that irradiation resulted in color and odor changes; vitE reduced TBARS while vitC increased the TBARS compared to the CD-IR treatment.

Key Words: Vitamin E, Vitamin C, Irradiation

1836 Effect of the addition of electrolytes in drinking water and the chilling temperature on technological, physicochemical, and microbiological characteristics of pork. A. Alarcon-Rojo, S. Mendoza*, and A. Grado, *Universidad Autonoma de Chihuahua. Chihuahua, Chih. Mexico.*

With the objective of determining the effect of the addition of electrolytes in pig drinking water during resting and the effect of chilling temperature on technological, physicochemical and microbiological characteristics of pork, two experiment were carried out using 280 pigs from a technified farm of the central region of Mexico. The objective of experiment 1 was to evaluate the effect of electrolytes on meat quality. 80 pigs were offered electrolyte-containing water as the only drinking source during resting time, whereas the other 80 pigs were reared conventionally with only water as a drinking source. The objective of experiment 2 was to evaluate the effect of chilled carcass internal temperature (10 and 12 C) on meat quality, and the design consisted of two groups of 60 animals held at each temperature. The addition of electrolytes did not significantly ($P>.05$) affect drip loss, water holding capacity, carcass and leg yield, pH and temperature at 24 h post mortem, but improved ($P<.05$) meat color (L* = 39.74 0.42, a* = 2.82 0.19, and b* = 11.59 0.19 for the treated group versus L* = 42.40 0.42, a* = 2.26 0.19 and b* = 10.36 0.19 for the control group), increased pH at 45 min post mortem (6.53 0.02 versus 6.45 0.02), decreased temperature at 45 min post mortem (34.95 0.05 versus 35.69 0.05 C) and decreased electrical conductivity at 45 min (4.45 0.08 versus 5.23 0.08 mS/cm) and at 24 h post mortem (5.06 0.09 vs. 5.85 0.09 mS/cm). Carcasses with 10 C chilled carcass internal temperature showed higher ($P<.01$) cold carcass yield (2.55 0.15 versus 1.84 0.15%) but boned leg yield, water holding capacity, color, pH, temperature, electrical conductivity and bacterial counts of meat were not affected ($P>.05$). It is concluded that the addition of electrolytes in pig drinking water during resting improves physicochemical characteristics of meat, whereas having a chilled carcass internal temperature of 10 C improves cold carcass yield.

Key Words: electrolyte, pork quality, chilling temperature

1837 Relationship between a measure of troponin-T degradation and beef tenderness. L. J. Rowe, E. Huff-Lonergan, G. H. Rouse, D. E. Wilson, and S. M. Lonergan*, *Iowa State University.*

Development of beef tenderness during postmortem aging is believed to be due to degradation of muscle proteins, which results in a decrease in structural integrity of myofibrils. Observations of proteolysis of troponin-T and subsequent production of a 30-kDa protein product during postmortem aging have been widely reported in the literature. The objective of the current study was to determine the relationship between Warner-Bratzler shear (WBS) values and the presence of the 30-kDa band using densitometry. Angus bull calves (n=128) were used to meet this objective. Samples (2.54 cm and 0.5 cm thick) were removed from the 12th rib region of the right side of each carcass. Steaks (2.54 cm) were sliced, vacuum packaged, aged for 14 d at 1 C and frozen until WBS analysis. Steaks were cooked to an internal temperature of 71C and cooled to room temperature. Six cores (1.25 cm) from each steak were used to determine WBS. The 0.5 cm sample was vacuum packaged, aged for 7 d at 1C and frozen. These samples were used to monitor protein degradation by immunoblotting using an anti-troponin-T antibody. An extract from a reference sample (beef loin aged 7 d) was used on each membrane to serve as a reference across blots. Relative intensity of the 30 kDa bands was determined using the Kodak 1D 2.0 software and a

digital camera (Kodak DC120; Eastman Kodak, Rochester, NY). A ratio (relative intensity of 30-kDa band in the sample/intensity of 30-kDa band in the reference) was used as a measure of proteolysis. Samples were classified to 5 groups based on detection of the 30-kDa band (0 = no proteolysis, 4 = most proteolysis). WBS at 14 d postmortem was significantly negatively correlated (-.433) with the relative intensity of the 30 kDa band present at 7 d postmortem. Samples that showed no proteolysis after 7 days had the highest WBS of any group ($P < 0.01$). Samples classified in group 4 had a lower WBS than groups 0, 1 and 2. The results indicate that measures of troponin-T degradation may be useful in identifying sources of variation in tenderness of beef.

Key Words: Beef, Tenderness, Troponin-T

1838 Use of color and near-infrared reflectance analysis to predict Warner-Bratzler beef longissimus tenderness. C.E. Realini^{*1}, T.D. Pringle¹, W.R. Windham², B.G. Lyon², S.K. Duckett¹, and K.R. Smith¹, ¹The University of Georgia, Athens, ²USDA-ARS, Russell Research Center, Athens.

This research used Angus heifers ($n=9$) to determine the ability of muscle color and near infrared reflectance (NIR) to predict tenderness of longissimus lumborum steaks. Lipid content, Warner-Bratzler shear force (WBS), Hunter L*, a*, and b* values, and visible (VIS) and NIR spectra were measured after 2, 4, 8, 14, and 21 d of aging. Shear force values were higher ($P < 0.01$) at 2 d than at all other aging times (5.9, 4.8, 4.7, 4.5, and 3.9 kg for 2, 4, 8, 14, and 21 d, respectively), and lower at 21 d ($P < 0.01$) than at other aging times. Hunter L*, a*, and b* values increased with aging time indicating that steaks became lighter, redder and yellower during postmortem storage. Correlations of WBS with colorimeter data were higher than with lipid percent. Among the color measures, L* values had the highest correlations with WBS except at 2 d of aging. Day 2 L* values accounted for 28.0, 20.4, 4.0, 0.1, and 6.9% of the variation in WBS, while lipid percent accounted for 3.2, 0.6, 7.9, 8.2, and 15.2% at 2, 4, 8, 14, and 21 d, respectively. Partial least squares (PLS) regression was used to predict WBS from VIS and NIR spectra. Spectra from three regions (400-780 nm, VIS; 780-1850 nm, NIR; and 400-1850 nm, VIS/NIR) were used in PLS modeling of WBS. The SE of cross validation and R² were 0.65 kg and 0.36, 0.71 kg and 0.37; and 0.57 kg and 0.52 for the VIS, NIR, and VIS/NIR regions, respectively. The first principal component (PC) from the VIS/NIR spectra indicated variation in WBS values was due primarily to absorption in the VIS region. Protein and fat absorption peaks at 1138 and 1390 nm, respectively, were present in the second factor, with no absorption peaks in the visible region. The third PC indicated absorption in the VIS region, and protein and fat in the NIR region. The first 3 PC explained 61% of the variation in WBS, and suggest that this prediction is based on information in both the VIS and NIR spectra. It is not clear whether the information in the VIS/NIR spectra was sufficient for practical meat tenderness prediction, and samples with larger variation in WBS are needed to more accurately define this relationship.

Key Words: Beef, Tenderness, Near-infrared

1839 Effect of conjugated linoleic acid supplementation on pork quality and fatty acid profiles. M.W. Greene^{*1}, T.D. Pringle¹, M.J. Azain¹, M.H. Gillis¹, S.K. Duckett¹, G.J. Hausman², and C.R. Barb², ¹The University of Georgia, Athens, ²USDA-ARS, Russell Research Center, Athens.

This study was conducted to determine the effects of supplemental conjugated linoleic acid (CLA) on pork quality and fatty acid composition.

Crossbred gilts ($n=15$) were fed a corn/soybean ration containing 0, 0.5 or 2.0% CLA and humanely harvested at the University of Georgia Meat Science and Technology Center. Backfat samples were removed immediately after slaughter for determination of fatty acid composition. Following a 24-h chill, carcasses were ribbed and carcass data, including visual color and marbling scores, were collected. Longissimus L*, a*, and b* values were recorded and samples were removed for lipid determination. CLA supplementation had no effect ($P > 0.05$) on daily gain, feed intake or feed:gain. Tenth rib backfat (0.69, 0.60, and 0.63; SEM=0.55) and loin eye area (6.0, 5.8, and 5.3; SEM=0.3) were numerically lower in CLA treated pigs. Neither visual longissimus color scores nor Hunter L*, a*, and b* values differed across treatments. Marbling scores were numerically higher in the 2.0% CLA-treated pigs than the control and the 0.5% CLA-treated pigs (1.5 and 1.5 vs. 1.8; SEM=0.3); which was consistent with the longissimus lipid percentages across CLA treatments (2.8, 3.0, and 3.4; SEM=0.3). Fatty acid profiles showed that CLA percentage in the subcutaneous fat increased ($P < 0.01$) as CLA in the ration increased (c9t11; 0.2, 0.6, and 1.6; SEM=0.1; t10c12; 0.1, 0.4, and 1.8; SEM=0.1). As expected, the percentage of saturated fatty acids in the backfat increased ($P < 0.05$; 32.0, 33.7, and 37.7; SEM=1.3) and monounsaturated fatty acids decreased ($P < 0.01$) as CLA concentration in the ration increased (42.7, 39.1, and 37.2; SEM=0.9). These changes were due primarily to incremental increases in the percentage of C18:0 and decreases in the percentage of C18:1 as dietary CLA increased. Dietary CLA supplementation significantly alters fatty acid composition; however, more research is needed to document significant compositional changes at the carcass level.

Key Words: CLA, Pork, Fatty Acids

1840 Perimysium structure and collagen content change with muscle type and myostatin inheritance. R Taylor^{*1}, R Labas¹, P Berge¹, and J Culioli¹, Meat Research Station, INRA.

Previous studies have shown that collagen content and heat stability change with muscle type and/or age. Less well characterized is how changes in collagen are expressed structurally, as changes in perimysium. To investigate this we studied three different models in beef cattle which may have changes in collagen and perimysium. Comparison of muscle types *Pectoralis profundis* (Pp), *Gluteus biceps* (Gb) and *Semitendinosus* (St) showed that Pp has more perimysium, measured histologically as % muscle surface area and as length, than St and Gb. Qualitative evaluation showed that the form of the perimysium was clearly different in Pp compared to St and Gb, which were not different. As expected the collagen content and thermal properties varied with muscle type. In the second model myostatin -/- animals, with extensive muscle hypertrophy, were compared to normal animals, myostatin +/- animals. Myostatin -/- animals had less perimysium as % area and length, more soluble collagen and less total collagen (approx.-30%). In the third model *Semimembranosus* muscle was compared in cows from 2 contrasting breeds and production systems, i.e. Holstein (dairy) and Salers (meat, "rustic", raised in highlands), and finished in similar conditions. The hypothesis was that both breed and production system affect perimysium and collagen properties. However, no difference was found in perimysium distribution or collagen parameters comparing these breeds. We conclude that the major growth gene myostatin and muscle type, but not Holstein versus Salers breeds, have significant effects on perimysium organization.

ASAS Beef Species

1841 Pre-slaughter condition scoring of Zebu Cattle. O.T.F. Abanikannda^{*1}, A.O. Leigh¹, O.Y. Apena¹, and O. Olutogun², ¹Department of Zoology, Lagos State University, Ojo - Lagos, Nigeria, ²Department of Animal Science, University of Ibadan, Nigeria.

Condition scoring provides a quick, cheap and easy method of assessing an individual animal brought to the abattoir for slaughter. In this study, nine scores were used in which the three main conditions: fat (F), medium (M) and lean (L) were further subdivided into three categories: F+, F, F-; M+, M, M-; L+, L and L-. Four-hundred, fifty-four

cattle comprising 362 male and 92 female, 26 polled and 428 horned were evaluated. Of the three main categories, 54.85% were fat, 29.30% were medium and 15.85% were lean. However, the F+ had the highest frequency (40.16%) of the fat, the M+ had 64.66% of the medium while L- had the highest frequency (80.55%) of the lean. It is not surprising that over half of the cattle brought to the abattoir and lairage belong to the F class. This is because most of the cattle that are better priced are those that are visually appealing and which are expected to yield higher meat to bone ratio. Lagos, being of cosmopolitan nature, boasts the best or choice grade of cattle, despite the fact that these animals are

not bred within the state. The poorly conditioned cattle are lower priced and often rejected right from the farm. When farmers decide to market such animals, they often can not withstand the rigours associated with cattle transportation and handling and usually are dead before reaching the market. This study provides a means by which cattle from different farms under differing management systems can be quickly and cheaply appraised and assessed.

Key Words: Condition Scoring, Zebu, Nigeria

1842 Safety of moxidectin 1% nonaqueous injectable solution for cattle. K.L. Simkins*, R.L. DeLay, and T.W.J. Olchoway, *Fort Dodge Animal Health, Princeton, NJ.*

Moxidectin is used in cattle for controlling internal and external parasites. The objective of this study was to evaluate the safety of moxidectin 1% nonaqueous injectable solution administered subcutaneously to crossbred cattle (244 to 298 kg BW) at dosages of 0.2, 0.6 or 1.0 mg moxidectin/kg BW (1X, 3X or 5X the expected use level) given 3 times with 7 day intervals. There were 4 steers and 4 heifers in each of the following groups: A (saline control), B (1X), C (3X) and D (5X). Physical exams were conducted before and after treatment. All animals were observed daily for clinical signs following treatments. Hematology, serum chemistry, urinalysis and fecal analysis were conducted at 3 and 1 days prior to treatment and at 6 days after each treatment. All animals were necropsied 7 to 10 days after the third treatment and examined for gross pathology. Histopathology was conducted on approximately 40 tissues for each animal in Groups A and D. Physical exams showed no treatment related abnormalities. There were no apparent adverse clinical reactions following treatment. Hematology results showed that none of the treated groups were different from controls ($P > .10$) for red blood cell counts, hematocrit, platelets and activated partial thromboplastin time. Hemoglobin concentration for Group D was lower than Group A (10.04 vs 10.42 g/dL, $P < .10$). White blood cell counts for Groups C and D were higher than controls ($P < .10$). However, all hemoglobin and WBC counts were within normal ranges. Serum chemistry results showed that none of the treated groups were different from controls ($P > .10$) for glucose, phosphorus, sodium, chloride, potassium, total protein and total bilirubin. Serum iron was lower in all treated groups compared to controls ($P < .10$), but all iron concentrations were within normal ranges. Urine, feces, gross pathology and histopathology evaluations showed no treatment related abnormalities. The results of this study show that moxidectin 1% nonaqueous injectable solution is safe for cattle following administration of the expected use level of 0.2 mg moxidectin/kg BW or 3X and 5X this level at weekly intervals for 3 consecutive weeks.

Key Words: Moxidectin, Cattle, Safety

1843 Effect of supplemental energy source on growth and reproductive performance of virgin heifers consuming corn silage diets. C.M. Howlett*, E.S. Vanzant, L.H. Anderson, W.R. Burris, J. Randolph, and R.F. Bapst, *University of Kentucky.*

Ninety-six crossbred, virgin beef heifers (249 kg) were used in a randomized complete block design to determine the effects of source of supplemental nutrients on average daily gain (ADG) and reproductive performance. Heifers were randomly assigned within each of three weight blocks to 4 pens of 8 heifers each. The four pens within each block were assigned at random to one of four diets based on corn silage (CP=8.2%, TDN=63.5%) at 42% DMI with minerals supplied at 2% DMI. Treatments were: 1) corn and soybean meal (CSBM) at 56% DMI; 2) whole linted cottonseed at 15% DMI (COT); 3) whole raw soybeans at 15% DMI (SB); or 4) pelleted soyhulls at 30% DMI (SH). In diets 2 through 4, COT, SB, and SH replaced a portion of the corn and soybean meal. Diets were formulated to be isonitrogenous (13.7% CP) and were fed at approximately 2.2 X NEM to achieve target weights equal to 65% of expected mature body weight at the time of AI. Animals were weighed every 28 d for 112 d with weights obtained on two consecutive days at the beginning and end of the treatment period. After each weighing, feeding levels were adjusted for each pen to account for weight gain. Beginning on d 113, treatments were discontinued and all groups were fed a common diet at an appropriate level to maintain target gains. Serum was obtained for progesterone analysis on days 112 and 119. Heifers were considered to have initiated estrous cycles if progesterone concentrations exceeded .5 ng/ml in either sample. Heifers were synchronized with an MGA/PG system and bred by AI in response to detected heat on days

154 to 156 (beginning 48 h after PG administration). Since the energy value for SH was underestimated, cumulative ADG for SH (1.02 kg/d) was greater ($P \leq .03$) than for CSBM (.88 kg/d), COT (.87 kg/d), or SB (.86 kg/d). Number of estrous cycling heifers prior to synchronization for each treatment were: CSBM (n=13, 54%), COT (n=12, 50%), SB (n=16, 66%), SH (n=16, 66%). First-service conception rates were unaffected ($P > .10$) by treatment: CSBM 7:19 (37%); COT 8:21 (38%); SB 12:22 (55%); SH 8:19 (42%). Numerical trends suggest that SB may increase reproductive performance independent of energy supply in virgin heifers consuming a corn silage based diet.

Key Words: Energy, Supplementation, Conception

1844 Influence of Estrus Synchronization on Reproductive Performance of Cows Exposed to Natural Service. J. D. Rhinehart*, J. W. Wyles, and L. H. Anderson, *University of Kentucky.*

We tested the hypothesis that estrus synchronization would affect the interval to pregnancy and pregnancy rate in postpartum cows. In this experiment, crossbred postpartum cows (n = 84) and two-year-old heifers (n = 24) were randomly assigned to one of three treatments and balanced by age and calving date. The treatments consisted of 1) exposure to orally active melengestrol acetate (MGA, 5 mg/head/day as a top-dressed supplement to the basal diet) from D -7 to D -1 (D 0= first day of breeding season); 2) seven days of MGA exposure with administration of 25 mg of prostaglandin F₂α (Lutalyse, Pharmacia & UpJon, Kalamazoo, MI) on D -1 (MGA+PG); or 3) fed only the basal diet (CONT). On D 0, each group was exposed to natural service for 60 days (1 yearling bull per eight females). All bulls were subjected to, and passed, breeding soundness exams on D -30. Date of pregnancy was determined using rectal palpation on D 140. Pregnancy rates differed ($P = .08$) among cows in the CONT (86%), MGA (92%), and MGA+PG (100%) groups. Interval to pregnancy (number of days from onset of the breeding season to conception) was lower ($P < .05$) for cows in which estrus was synchronized (MGA, MGA+PG) than for cows which were not (CONT). Interval to pregnancy tended ($P = .13$) to differ between cows in MGA and MGA+PG groups. From these results we concluded that estrus synchronization, prior to natural service, improved reproductive performance in postpartum cows.

Key Words: Estrus Synchronization, MGA, Natural Service

1845 Influence of calving on body condition score in crossbred cows. Sarjan rao Kapa*¹, Dilipkumar Garikipati¹, and Kailash MM², ¹College of veterinary science, Tirupati, Angraui, ²University of Agricultural science, Bangalore.

A five-point body condition score technique based on visual, tactile or combined assessment of the amount of body condition carried by the cow was employed on 216 crossbred HF cows to study the postpartum changes in BCS. The BCS observed for all the first calvings and all other (2 through 4) calvings were 3.18 ± 0.39 and 3.52 ± 0.54 , respectively. The BCS at 60 days, 120 days and loss at 120 days of all lactations were 3.12 ± 0.79 , 3.06 ± 0.68 and 0.87 ± 0.62 , respectively were observed. The body condition loss ranged from 0.50 to 1.09 over the BCS range of 2.5 to 4.5 with an average of 0.27 points increase for every one unit higher initial BCS. The magnitude of condition loss depended primarily on score at calving and was greater for cows that calved with high BCS. After reaching the minimum score, cows gained the range of BCS from 0.18 to 0.27 and with an average gain of 0.04 points for every increase of one unit of BCS. The total amount of gain was mainly influenced by BCS at calving and by milk yield. The loss in BCS was low in comparison with gain in BCS. A quadratic relationship ($P < 0.0001$) existed between lactation number and BCS at calving with FCM production to 90 days in milk (DIM). The change in BCS from calving to 60 days vs 90 days FCM production was quadratically ($P < 0.0001$) related to lactation number which showed that lactation number accounted for most of variation in milk production. The BCS varied quadratically with days in milk and month in milk within each lactation. Mean BCS for 30 days lactation was significantly ($P < 0.05$) different at 241 to 270 days and ($P < 0.01$) at 90 to 120 days. All other 30 days of milk intervals and dry periods were not significantly different from respective adjacent 30 days lactation intervals. There was a significant difference in BCS between early dry cows and late dry cows.

Key Words: Body Condition Score, Days in Milk, Fat-corrected Milk

1846 Maternal performance of four biological types of Red Poll cows. B.A. Sandelin*¹, A.H. Brown, Jr.¹, Z.B. Johnson¹, A.M. Stelzleni¹, and C.F. Rosenkrans, Jr.¹, ¹University of Arkansas.

Maternal performance of four biological types of Red Poll cows born, reared and managed on Ozark Mountain range were evaluated. Growth curve parameters of mature weight (A) and maturing rate (k) were estimated for 59 Red Poll cows using the Brody Model. Cows were assigned to one of four biological types: large late maturing (LL, A > 455 kg, k < 0.0500%), large early maturing (LE, A > 455 kg, k > 0.0500%), small late maturing (SL, A < 455 kg, k < 0.0500%), and small early maturing (SE, A < 455 kg, k > 0.0500%). Weights for calves were recorded at birth, 120, 240, and 360 d. Distribution of calf weights by biological cow type included: LL (n = 99), LE (n = 37), SL (n = 24), and SE (n = 85). Age and age of dam adjusted calf weights were analyzed using a model that included terms for an overall mean, year, type, sire, sex, interactions of type x year and type x sex, and residual error. Year, type, and

sex were considered fixed effects and sire was considered a random effect. Year x type interactions were significant for weight at all ages, but sex x type interactions for weight were not significant at any age. Calves born to the four biological cow types had similar (P > 0.05) mean birth and 360 d weights. Small, early maturing cows had calves with smaller (P < 0.05) mean 120 d weights than calves of other biological types (135.5 vs 145.4, 147.5, 148.6 kg). Large and small, late maturing cows and LE cows produced calves with similar (P > 0.05) mean 240 d weights (217.4, 215.6, and 211.6 kg) and their calves were heavier (P < 0.05) than those of SE cows (197.4 kg). However, there was no difference (P > 0.05) in the 240 d weights between the LE and SE cow types. Mean weaning rates for LL, LE, SL, and SE cows were 85.5, 82.7, 76.8, and 83.4%, respectively. These data suggest that size and maturing rate of Red Poll cows managed with limited resources, influences preweaning calf performance, but may not affect weaning rate.

Key Words: Mature weight, Maturing rate, maternal performance

ASAS Goat Species and ASAS Companion Animal Species

1847 Evaluation of Corn Gluten Meal as a Protein Source in Canine Diets. R.M. Yamka*¹, S.E. Kitts¹, A.D. True¹, D.L. Harmon¹, and W.D. Schoenher², ¹Dept. of Animal Sciences, University of Kentucky, Lexington, 40546, ²Hill's Pet Nutrition, Topeka, KS 66617.

Ten mature dogs (19.0 kg + 0.4 kg) surgically fitted with ileal T-cannula were used in an experiment to determine the feeding value of corn gluten meal (CGM) in a complete diet fed to dogs. All diets contained 10% poultry meal and graded levels of CGM (0 to 32% DM) resulting in diets that were 10, 15, 20, 25 and 30% crude protein. Daily dry matter (DM) intake averaged 307 + 7 g/d. An increase in CGM resulted in an increase in fecal moisture from 51.6 to 57.5% (linear; P < 0.0001) and fecal DM output increased from 24.2 to 32.9 g/d (linear; P < 0.0001). Ileal DM flow increased from 34.8 to 51.3 g/d (linear; P < 0.0004). Small intestinal DM digestibility decreased from 88.9 to 83.4% (linear; P < 0.0002) and total tract DM digestibility decreased from 92.3 to 89.4% (linear; P < 0.0001) as CGM increased. Large intestinal digestibility (29.4% DM) was not affected by treatment. Crude protein (CP) fecal excretion increased from 5.6 to 8.1 g/d (linear; P < 0.0004) and ileal flow of CP increased from 9.4 to 16.9 g/d (linear; P < 0.002) as CGM increased. Small intestinal CP digestibility increased from 73.4 to 82.5% (linear; P < 0.002) with increasing CGM. Large intestinal CP digestibility was not affected by treatment (40.4% DM). Total tract CP digestibility increased from 84.5 to 91.1% (linear; P < 0.0001) as CGM increased. Disappearance of all amino acids (g/d) increased (linear; P < 0.0001) with increasing CGM. Glutamate had the highest disappearance ranging from 3.83 to 16.16 g/d. Histidine had the lowest disappearance ranging from 0.49 to 1.41 g/d. Arginine had the highest overall digestibility ranging from 86.2 to 87.6% whereas, threonine had the lowest digestibility ranging from 64.7 to 75.1%. These data indicate that CGM is a highly digestible protein source for canine diets with dietary inclusions of 8.4 to 32.2%.

Key Words: Corn Gluten Meal, Amino Acid, Canine

1848 The effects of an antioxidant system based on tocopherols and novel extracts from Rosemary on petfood shelf-life and acceptability by dogs and cats. C. G. Aldrich* and J. O. Mann, Kemin Americas, Inc., Des Moines, IA.

A study was conducted to determine the shelf life and palatability of extruded petfood stabilized with tocopherols and novel extracts from rosemary. The treatments included a negative control in which fat was not treated with an antioxidant, a positive control in which fat was treated with NaturoxTM at 3000ppm, and fat treated with an experimental formula, RX13, at 3000 ppm. NaturoxTM is a tocopherol-based antioxidant system, whereas RX13 is a blend of tocopherols and the novel extract of purpose-bred rosemary. Equal portions of fat were applied internally and externally during processing in an Extrutech E525 extruder run at a rate of 800 lb/hr. Diets consisted of corn (49.5%), chicken by-product meal (30%), chicken fat (10%), beet pulp (4%), egg (3%) and yeast (3%), as well as, minerals and vitamins to 100%. Processing conditions remained constant for the test runs. In the oxygen bomb analysis, an accelerated shelf-life method, an induction time of 3.85 h was recorded for

the negative control. This compared to 6.75 h for the positive control; petfood that contained tocopherol-based NaturoxTM. The experimental formula, RX13, had an 11.2% longer predicted shelf-life than the positive control with an induction time of 7.60 h. Crude extracts of rosemary contain compounds that impart a distinctive aroma to which dogs and cats have an aversion. It is necessary to remove these volatile compounds through the use of rolled-film evaporation. To verify that the negative aromas were removed, the NaturoxTM and RX13 diets were fed to 20 Beagle dogs and 20 American Shorthair cats in a 4 day split-plate palatability test. In dogs, first bite, a reflection of aroma, was not affected by treatment (1.00:1.11). Likewise, total consumption, an indication of flavor, was not different (1.30:1.00). In cats, a similar result was observed in that first bite was similar between treatments (1.59:1.00), as was total consumption (1.34:1.00). It was concluded from this study that the novel extract of purpose-bred rosemary and its subsequent deodorization was an effective component of an antioxidant system for the stabilization of fat in extruded pet foods.

Key Words: Rosemary extract, Shelf-life, Palatability

1849 The effect of hay and /or concentrate on performance, organ mass, blood metabolites and hormones in weaned kids. B. Kouakou*, S. Gelaye, G. Kannan, T. H. Terrill, E. A. Amoah, and S. Miller, Agricultural Research Station, Fort Valley State University.

Weaned kids (BW = 12.6 kg; n = 12) were used in an experiment to determine the effect of hay, concentrate, or concentrate following hay feeding on performance, organ mass, thyroid hormones and blood metabolites. Kids were stratified by BW and randomly assigned to dietary regimen. Chopped rhizoma peanut (*Arachis glabrata*) hay or an 18% CP concentrate diet were fed during the two periods of 60 d each. During the first period, two groups of kids (n = 4; total = 8) were fed hay alone, and one group (n = 4), the concentrate diet. During the second period, one of the hay-fed groups (n = 4) was switched to the concentrate, while the other groups remained on the previous diets (hay, n = 4; concentrate, n = 4). Dietary treatments were identified as HH (Hay, Hay), HC (Hay, Concentrate) and CC (Concentrate, Concentrate) to indicate hay or concentrate for first and second period, respectively. Weights, feed and blood samples were taken every 20 d. At the end of the second period (120 d), all animals were slaughtered and digestive tract (reticulo-rumen and intestines including digesta), liver and hot carcass weight were recorded. Blood samples were analyzed for BUN, NEFA, glucose, T₄ and T₃. In period one, T₄ and T₃ were higher (P < .05 and P < .01, respectively), BUN and NEFA were lower (24.9 vs 33.4 mg/dL and 159.9 vs 271.8 mEq/L, respectively) in concentrate-fed than in those fed hay. Glucose levels were similar (57.8 mg/dL) for hay or concentrate-fed kids but BW gain was greater (P < .01) for concentrate-fed than for hay-fed animals. During period two, gain was similar (3.25 vs 4.25 kg for HC and CC animals, respectively) and T₃ was highest (P < .01) in HC followed by CC and HH animals. Both groups of animals fed concentrate in period two had lower (P < .05) levels of NEFA (483 and 415.6 vs 1264 mEq/L) and higher levels of glucose (69.9 and 53.6 vs 43.5 mg/dL) than those fed hay. Overall gain was highest (P < .01) for CC (11 kg) followed by HC (5.5 kg) and HH (1 kg) animals. Liver

weights were similar (424 and 388.5 g) for CC and HC but greater ($P < .01$) than in HH (247 g) animals. Digestive tract as a percent of BW was higher ($P < .01$) for HH than HC and CC animals. These results suggest that concentrate feeding increases liver weight, level of T_3 and decreases digestive tract mass as a percent of BW.

Key Words: Goat, Hormones Metabolites, Organ mass

1850 Weight Gain In Beetal Goats Under Two Different Rearing Systems. S. H. Raza*, A. Iqbal, and M. Abdullah, *University of Agriculture, Faisalabad, PAKISTAN.*

Amongst the goat breeds of Pakistan "Beetal" goat is important due to its better production performance. Goats are reared under extensive to semi extensive systems. Their production under "zero" grazing has not been explored. In this study production potentials of Beetal male animals under "zero" grazing and "total" grazing systems were tested. 24 Beetal male animals were randomly allotted to 2 treatments viz., "A" and "B", having 12 animals each. Animals under treatment "A" were allowed grazing along with a supplement of 200 g of concentrate/head. The animals in group "B" were kept indoors under "zero" grazing and fed green fodder *ad libitum* along with concentrate as in case on "A". The animals were kept on treatments for 100 d including 7 d of adjustment period. The data on weekly weight gain were recorded to calculate daily weight gain. At the end of the experiment, 2 animals from each group were slaughtered and data on different carcass parameters were recorded. Data analysis revealed that weight gain in both the groups differed significantly. Animals in treatment "A" gained 0.0236g more weight/d than animals on "zero" grazing. The dressing (12.63±0.63, 11.25±0.52), head and trotters (3.05±0.35, 2.80±0.28) and pluck (1.45±0.07, 1.45±0.00) weights (Kg) were found to be non significant for "A" and "B". The dressing, head and trotters and pluck percentages were found to be 49.50 and 44.10; 11.43 and 10.95 and 5.70 and 5.75, respectively. The dressing % was almost 1.38 Kg more for group "A" with non-significant difference. The values for bone (33.00, 42.08) and fat (6.25, 6.65) percentage were also found to be, statistically, non significant for "A" and "B" but the lean meat weight (Kg) differed significantly ($P < 0.05$) in group "A" (44.65±0.85) than animals on zero grazing 40.75±0.25. It can be concluded that under prevailing conditions, for the rearing of this free ranging animal, extensive system is most suitable unless a reasonably longer adjustment period from the time of birth is not provided.

Key Words: Goat, grazing, carcass

1851 Preslaughter stress effects on physiological responses and meat quality characteristics in goats. G. Kannan*, B. Kouakou, T. H. Terrill, S. Gelaye, and E. A. Amoah, *Agricultural Research Station, Fort Valley State University, Fort Valley, GA.*

This experiment was conducted to determine the effects of transportation stress on physiological responses and meat quality characteristics in dairy goats of different age groups. The goats ($n = 28$) were classified as young (Y, 6 to 12 mo of age) and old (O, 24 to 30 mo of age) groups (AGE), feed deprived overnight, and slaughtered in three replicates. On the day of each replicate trial, one group was subjected to a two-hour transportation (T) to impose stress and the other group was held (H) in holding pens (treatment, TRT) prior to slaughter. Blood samples were collected from both T and H goats at 0, 1, and 2 h after beginning of transportation (TIME). Meat quality was assessed on Longissimus dorsi muscles. The data were analyzed as Split-Unit designs using MIXED procedures in SAS. The T goats had higher plasma cortisol concentrations than H goats ($P < 0.01$), however, plasma leptin, T_3 , and T_4 concentrations were not affected by TRT, TIME, or TRT x TIME. The initial (15 min postmortem) and ultimate (24 h postmortem) muscle pH were not influenced by TRT. Muscle glycogen concentrations were higher in H than in T animals ($P < 0.05$). Muscle glycogen was also higher in O compared to Y goats ($P < 0.01$), and the decline in glycogen over 24 h was not influenced by TRT or AGE. Water holding capacity and CIE $L^*a^*b^*$ color values, measured at 24 h postmortem, were not affected by TRT. The O group had lower L^* values ($P < 0.01$) and greater a^* ($P < 0.01$) and chroma ($P < 0.01$) values than the Y group. Cooking loss and Warner Bratzler shear (WBS) values of loin chops, vacuum packed and aged for different times (0, 6, and 12 d), were not influenced by TRT. Age of animal ($P < 0.01$) and meat aging time ($P < 0.01$) influenced WBS, as expected. The data indicate that short-term

preslaughter transport can cause significant changes in stress response and muscle metabolism in goats, although the overall meat quality may not be affected.

Key Words: Goats, Preslaughter stress, Meat quality

1852 Live weight changes in grazing goats supplemented with protein during the dry season. A.S. Juarez-Reyes, M.A. Cerrillo*, and G. Nevarez-Carrasco, *Universidad Juarez del Estado de Durango, Durango, Dgo. Mexico.*

Sixty criollo goats were arranged into four groups, fifteen animals each, according to a randomized block design to determine the effect of protein supplementation on weight loss during the dry season (January-June) in a semi-arid region of northern, Mexico. The supplementation requirements were determined by two protein systems named: Digestible Intestinal Protein (PDI) (Verite *et al.*, 1987) and Metabolizable Protein (Burroughs *et al.*, 1975). The protein supplements ($T_1 = 10$ g wheat hulls + 120 g cotton seed meal; $T_2 = 10$ g wheat hulls + 120 g poultry litter; $T_3 = 10$ g wheat hulls + 60 g cotton seed meal + 60 g poultry litter; $T_4 =$ control) were offered to the animals once a week. Statistical differences ($P < .05$) in weight loss were found between the animals fed the supplement and the control group 120 d from parturition. The effect was even more evident 150 d from parturition where the control group lost 13 kg (34% of the weight registered at parturition), whereas the supplemented animals lost from 7 to 8 kg ($T_1 = -7.9$; $T_2 = -7.4$; $T_3 = -8.1$), which corresponds to 20-22% of the weight at parturition. The results obtained in this study indicate that the weight loss in the control group makes the animals extremely vulnerable to the rough climatic conditions at the beginning of the rainy season, whereas the supplement guarantees the survival of the goats during the dry season.

Key Words: Goats, Grazing, Supplementation

1853 Determination of supplementation requirements of grazing goats utilizing two protein systems. A.S. Juarez-Reyes*, M.A. Cerrillo, and G. Nevarez-Carrasco, *Universidad Juarez del Estado de Durango, Durango, Dgo. Mexico.*

Three goats fitted with esophageal and ruminal cannulae (38 ± 1.7 kg BW) from a flock of 250 grazing animals, were used to estimate the intake of metabolizable protein (IMP) and content of metabolizable protein in the diet (DMP) utilizing two protein systems. Values from crude protein, *in situ* degradability of crude protein (48 h incubation) and content of TDN were incorporated into the Burroughs' Metabolizable Protein System (USA). The values used for the French Intestinal Digestible Protein System (IDP) were crude protein, *in situ* degradability of crude protein and organic matter fermented in rumen were utilized. Extrusa samples were collected twice a day (12:00 and 16:00) for two consecutive days per month. Two periods of sampling were evaluated, the dry season from February to June and the rainy season, from July to November. Data were analyzed in a completely randomized block design. Means obtained from MP system were 11.7%, 85 g/kg DM and 127 g/d for the CP, DMP and IMP respectively; whereas for the IDP System the data obtained were 11.7%, 74 g/kg MS and 110 g/d for CP, DMP and IMP respectively. To determine the ruminal nitrogen-energy balance in the MP system, the urea fermentation potential (UFP) was used, whereas for the French system, the difference between the intestinal digestible protein originated from nitrogen (NIDP) and energy (EIDP) was utilized. Data indicated that the UFP for the dry season was 5.2 g/kg DM suggesting the necessity to incorporate this amount of urea to the diet. The value of -14.4 g/kg DM for the rainy season indicates that no urea is required. The difference between NIDP and EIDP was 15 g/kg DM in favor of EIDP during the dry season; no difference was registered for the rainy season ($P > .05$). Results from both systems indicate that a source of degradable protein in the diet of grazing goats is required during the dry season to increase the amount of microbial metabolizable protein.

Key Words: Grazing goats, Metabolizable protein, Supplementation

1854 Effects of urea treatment of straw and dietary broiler litter on feed intake and digestion in Spanish wethers. G. Abebe¹, R. C. Merkel^{*2}, G. Anmut³, A. L. Goetsch², and T. Sahlu², ¹Awassa College of Agriculture, Debub University, Awassa, Ethiopia, ²E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK, ³Alemaya University, Dire Dawa, Ethiopia.

Eight Spanish wethers (29.3 ± 1.15 kg) were allocated to simultaneous 4 × 4 Latin squares to test effects on intake and digestion of urea treatment of wheat straw and supplementation with different levels of broiler litter (BL). Wheat straw, untreated (U, 0.41% N; DM basis) or treated with urea (T, 2.25% N), was consumed *ad libitum*; supplement treatments (ST) were C: corn-based (1.42% N, 0.64% BW); S: C + 0.25% BW soybean meal (3.10% N, 0.89% BW); L: C + 0.5% BW BL (2.97% N, 1.14% BW); and H: C + 1.0% BW BL (3.06% N, 1.64% BW). Chromic oxide was included in supplements to estimate apparent digestibilities. Straw type and ST did not interact in OM and N intakes and digestibilities. Straw OM intake was similar between U and T; total OM intake was greatest among ST (P < 0.05) for H and lowest (P < 0.05) for C (476, 566, 649, and 739 g/d for C, S, L, and H, respectively). Digestibility of OM was not influenced by straw type, but was lower (P < 0.10) for L and H than for C and S (67.9, 68.3, 61.9, and 60.7% for C, S, L and H, respectively; SE = 2.5). Digestible OM intake (DOMI) was greater (P < 0.05) for T than for U (436 vs 327 g/d); among ST DOMI was lowest (P < 0.05) for C and greater (P < 0.05) for H vs S (314, 377, 396, and 440 g/d for C, S, L, and H, respectively; SE = 19.6). Intake of straw N was greater (P < 0.05) in goats consuming T than U (9.7 vs 1.0 g/d) and greatest among ST for H (8.0, 13.6, 15.8, and 19.6 g/d for C, S, L, and H, respectively). Apparent N digestibility was not affected by straw type and was greatest among supplement treatments (P < 0.05) for S (51.5, 67.8, 51.4, and 46.4%, for C, S, L, and H, respectively). In conclusion, improvements in DOMI by supplementing a basal wheat straw diet with S or BL were not influenced by urea treatment. The increase in DOMI with a low level of BL (i.e., 0.5% BW) was comparable to that with S, and greater change occurred with 1.0% BW BL.

Key Words: goats, wheat straw, broiler litter

1855 Feed intake and growth by Spanish and Boer × Spanish doelings consuming diets with different levels of broiler litter. T. Negesse¹, R. C. Merkel², A. Tolera¹, A. L. Goetsch², T. Sahlu², R. Puchala², T. A. Gipson², and L. J. Dawson^{*2}, ¹Awassa College of Agriculture, Debub University, Awassa, Ethiopia, ²E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK.

Sixty Spanish (S) and 40 Boer × S (BS) doelings, 14.9 ± 3.8 and 21.9 ± 3.8 kg, respectively, were allocated to five treatments in an 84-d experiment (four 21-d periods) to test effects of dietary level of broiler litter (L) on feed intake and ADG. Six S and four BS doelings were assigned to two replicates per treatment. Treatments were OL: 20% chopped millet hay (H; 6.1% CP, DM basis) + 80% concentrate (11.9% CP); 20L: 20% H + 80% concentrate (12.9% CP) with 20% dietary L; 40L: 20% H + 80% concentrate (17.0% CP) with 40% dietary L; 60L: 20% H + 80% concentrate (21.0% CP) with 60% dietary L; and 80F: 80% H + 20% concentrate (24.4% CP). Diets were consumed *ad libitum*, group feed intake was determined daily, and BW was measured at 21-d intervals. DMI differed (P < 0.05) among all treatments in period 1 (772, 620, 683, 371, and 468 g/d; SE = 12.6) and 2 (816, 657, 748, 347, and 579 g/d; SE = 11.1) for 0L, 20L, 40L, 60L, and 80F, respectively. Goats consuming 0L had greatest and 60L lowest (P < 0.05) DMI in period 3 (938, 825, 859, 557, and 832 g/d; SE = 15.9) while in period 4, DMI was greatest for 0L and 40L and lowest (P < 0.05) for 60L (1,007, 933, 1,007, 682, and 905 g/d; SE = 19.9) for 0L, 20L, 40L, 60L, and 80F, respectively. ADG was similar between S and BS with 60L but greater (P < 0.05) for BS with other diets, and the difference between genotypes in ADG was greatest among treatments with 0L (interaction, P < 0.05). ADG of S was 108, 81, 71, 9, and 37 g/d (SE = 8.7), and that of BS was 177, 118, 105, 12, and 58 g/d (SE = 10.6) for 0L, 20L, 40L, 60L, and 80F, respectively. In conclusion, S and BS doelings can be fed diets with up to 40% L for growth comparable to or greater than that with a low quality forage-based diet, and diets with moderate to high levels of L or based on low quality forage may lessen differences in ADG between S and BS compared with concentrate-based diets.

Key Words: goats, broiler litter, growth rate

1856 Comparison of goats raised intensively versus pasture raised. N.C. Beckford^{*}, J.M. Dzakuma, E. Risch, C.O. Smith, P.M. Johnson, and L.C. Nuti, *Prairie View A&M University, Prairie View, TX, USA.*

After weaning at 70±7 days of age 72 kids of Tennessee Stiff-legged (TS), Spanish (SP) and Boer (BR) breeds were individually fed an 18% CP and 65% TDN diet. These breeds represent goats with small, intermediate and large mature sizes (TS, SP, and BR). An equal number of offspring randomly selected from both sexes (36 Females and 36 Males) were used. They were divided into three groups of 8 per breed. The first group was fed *ad libitum*. The second and third groups were fed at 85% and 70% levels of the *ad libitum* diet. An equal number of kids born of the same breeds were maintained on pasture and run with their dams. One half the population of kids were creep fed and the other half were not. After weaning, both creep and non-creep fed goats were randomly assigned to pasture only and pasture with supplementation (corn). Goats in stalls were weighed biweekly and those on pasture monthly. All kids were slaughtered at approximately 6 mo of age. Birth weights were similar for BR and SP breeds (3.47 and 3.30 kg) and differed significantly (P<.05) from TS breed (2.75 kg). On goats fed the formulated ration at weaning, however, the BR breed (23.5 kg) was significantly heavier (P<.001) than the TS breed (14.76 kg) which also differed from the SP breed (11.81 kg). On pasture, the BR weighed 21.8 kg and was significantly heavier (P<.001) than the TS and SP breeds which were similar and weighed 13.7 and 14.45 kg, respectively. Kids from all 3 breeds that were creep fed were only slightly heavier (P<.17) than those that were not (17.4 vs 16.0 kg). Prior to slaughter, goats that had been creep fed were significantly heavier (P<.05) than those that had not (25.1 vs 21.8 kg). Within each breed, goats that were supplemented on pasture showed increases in weight (P ranging from P=.08 to P=.11) compared to those not supplemented. On the average, goats that had been raised intensively (BR 32.7; SP 16.3 and TS 21.1 kg) were heavier than those raised on pasture (BR 26.4; SP 24.4 and TS 19.6 kg). The cost benefit of raising goats intensively versus pasture raised will be evaluated. The study suggests supplementing pasture raised goats.

Key Words: Tennessee Stiff-legged, Spanish, Boer, Goats, Pasture, Intensive

1857 Survey of goat meat sales in New Jersey. James Lechner^{*}, James Wohlt, Ramu Govindasamy, and Patricia Schoknecht, *Rutgers, The State University of New Jersey, New Brunswick, NJ.*

Goat meat may be a potential specialty product for farmers in the Eastern U.S., due to the large ethnic populations within this region and their consumer preference for this product. To determine the potential market for goats, 368 butcher shops in the state of NJ (listed in the yellow pages) were surveyed. Surveys were initially conducted by phone establishing that shops sold goat meat. Then in-person surveys with the butchers were conducted, using a translator when necessary, to record data on both supply source and consumer preference for goat meat. A total of 65 shops (18%) sold goat meat year-round, with an additional 34 shops (9%) willing to order goat meat when requested. A majority of the butchers, 42% acquired goat meat from a distributor, with 28% of the meat obtained from a distributor being imported. Butcher shops in northern NJ sold most of their goat to either a European or Muslim consumer, while in southern NJ the consumers were primarily Caribbean. European and Muslims preferred carcasses or select cuts, while Caribbean's preferred cubed meat. All meat purchased by butchers averaged \$3.72/kg, with an average sale price of \$6.14/kg for carcasses, \$6.16/kg for legs and \$5.61/kg for cubed meat. Shops sold an average of 145 kg/wk. Findings indicate that the NJ goat market is very price sensitive. Over 55% of the shops indicated that the consumer would not pay more for a higher quality product and 75% indicated that the consumer base would not be broadened if a higher quality product were available. The major source of goat meat sold in NJ is either goat trucked in live from Texas and sold for \$40/head or meat imported from Australia and New Zealand which sold for an average of \$3.39/kg. Our data suggests that NJ butcher shops would not have a market for a higher quality, higher priced product, making it difficult for eastern goat producers to compete with the established supply channels.

Key Words: Goat meat, Butcher shops, Marketing

1858 Extension of the Cashmere Growth Period in Spanish Goats with Melatonin. T. Wuliji*¹, A. Litherland², A.L. Goetsch¹, T. Sahl¹, R. Puchala¹, T.A. Gipson, and L.J. Dawson¹, ¹*E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK*, ²*AgResearch, Grasslands Research Centre, Palmerston, New Zealand*.

Melatonin suppresses blood prolactin levels, and the prolactin surge in fur animals is usually associated with fiber shedding. Therefore, use of melatonin to induce out-of-season breeding could affect the seasonal pattern of cashmere fiber growth in goats by extending the active, anagen phase. Eighty 80 female Spanish goats (15 2 yr of age and 65 doelings) were used to determine influences of spring melatonin treatment on cashmere fiber growth. Treatments were control (C); melatonin implant (18 mg; Regulin, Shering Pty. Ltd.) without (I) and with three bromocryptine mesylate (215 mg) implants (IB) (Innovative Research of American, Sarasota, FL); and oral administration of melatonin (3 mg/d for 5 wk) (Sigma Chemical Co., St. Louis, MO) without (O) or with bromocryptine mesylate (OB). Melatonin treatments started 5 wk before breeding. Cashmere growth was examined by clipping fiber regrowth in a 10 x 10 cm area on the mid-side each month. Mean daily clean fiber growth rate (mg/d) estimated by mid-side patch clipping was greater ($P < 0.05$) for melatonin-treated groups compared with C in April (44.7, 82.9, 77.5, 80.6 and 71.5 mg/d) and May (39.6, 69.8, 81.4, 63.9 and 63.5 mg/d); in the overall 12-mo period fiber growth was greatest ($P < 0.05$) among treatments for I and IB (12.5, 15.9, 15.3, 13.1, and 12.9 g for C, I, IB, O, and OB, respectively). Mean cashmere fiber diameter was greater ($P < 0.05$) for I, IB, O and OB compared with C (17.4, 18.7, 18.9, 18.4, and 18.1 microns) in a pooled sample for February, March, and April, while in May, June, and July diameter for C was lowest ($P < 0.05$) among treatments (16.8, 18.6, 18.7, 18.4, and 18.8 microns for C, I, IB, O, and OB, respectively). In conclusion, spring melatonin treatment for out-of-season breeding appeared to extend the period of cashmere fiber growth, and the lack of effect of bromocryptine mesylate suggests no additive effect to melatonin treatment. Oral administration of melatonin had effects on cashmere fiber growth measured by mid-side patch similar to those of an implant early in the experiment, but over the entire 12-mo period fiber growth was not influenced.

Key Words: Goats, Cashmere fiber, Melatonin

1859 Milk yield, body weight and some physiological traits of Baladi goats and their crosses with Damascus and Anglo-Nubian breeds in Egypt. A. Hassan, M. Samak, A. Elkomy*, and M. Anwar, *Fac. of Agric. Alex. ElShatby, Egypt*.

Thirty lactating goats (10Baladi, B, (10BaladixDamascus, BxD) and (10BaladixAnglo-Nubian, BxA-N), one week post partum were used in this study to evaluate lactation performance and some blood parameters. Milk and blood were sampled biweekly intervals. Results showed that milk yield, total solids and fat percentages were significantly ($P < 0.01$) affected by breed. These values were 1.17kg, 14.54 and 4.83%, respectively which were higher in (BxD) cross than (BxA-N) or (B) goats. Parity had significant effect on milk yield and protein % ($P < 0.01$) and fat % and lactose % ($P < 0.05$). In the second parity milk yield and fat % were higher, while lactose and protein percentages were higher in the first one. Throughout the duration of lactation, only milk yield, TS % and fat % were significantly affected ($P < 0.01$). Counts of (RBC) and (WBC) and (PCV%), but not (HB%) were significantly affected ($P < 0.01$) by breed. Parity had significant effect ($P < 0.01$) on RBC counts and PCV% only. Regarding blood composition, breed had a significant effect on percentages of glucose, total lipids, albumin, A:G ratio, calcium (Ca), inorganic phosphorous (P), Ca:P ratio and Got and Gpt. Results indicated that parity affected, significantly, all the biochemical parameters studied, except albumin and (P). Kid's body weight was significantly affected by breed, sex and type of birth, but not parity.

Key Words: Milk, Blood, Goats

1860 Differences in growth and carcass characteristics in young goats of different genotypes. R. Kraig Peel*¹ and W. Shawn Ramsey², ¹*Sam Houston State University*, ²*Texas A&M University*.

Boer-Spanish (BxS), Boer-Angora (BxA), Angora-Spanish (AxS), Spanish (S), Angora (A), and 12 Boer-Spanish intact males (BxSi) were used to compare ($n=175$) genotypic effects on performance and carcass quality

in pasture and feedlot. Feedlot goats were fed ad libitum diets containing 64 % TDN and 14% CP. Using 20 d adjustment, weights were taken at 14 d intervals for 154 d with refusals taken every 3 d. Pasture goats were grazed on native Texas range and weighed at 14 d intervals. BxS had the highest ($P < .05$) AGD followed by the BxA and S (143 g/d, 119 g/d and 116 g/d). Angora and SxA had the lowest ($P < .05$) ADG (81g/d and 91 g/d). Feed efficiency and intake followed the same trend as ADG with BxS consuming the most feed (1.15 kg/hd/d) and A consuming the least (.89 kg/hd/d). BxS were the most efficient ($P < .05$), A were least efficient ($P < .05$) (7.55 kg/kg vs. 11.70 kg/kg). Generally, BxS had the heaviest carcasses, least fat at the 12th rib, largest loin eye area, largest leg circumference, highest percent kidney and pelvic fat (KP), and produced the longest carcasses. Generally A observations were the lowest for all attributes considered. The BxA goats did deposit more ($P < .05$) body wall fat over the 12th rib (1.91 cm vs .16 cm- all breed avg.). No differences were observed due to breed type in pasture goats. Fed goats gained faster and produced fatter, heavier muscled carcasses than pasture goats. Castration increased feed efficiency, percent hindsaddle, body wall thickness and percent KP, ($P > .05$).

Key Words: Goat, Carcass

1861 Effects of insulin administered to a perfused area of skin in Angora goats. R. Puchala*¹, S.G. Pierzynowski², T. Wuliji¹, A.L. Goetsch¹, and T. Sahl¹, ¹*E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK 73050*, ²*Department of Zoophysiology, Lund University, Lund, Sweden*.

The effect of insulin infusion on mohair growth of Angora goats was investigated using a skin perfusion technique. Six Angora wethers (average BW 32 4 kg) were implanted bilaterally with silicon catheters into the superficial branches of the deep circumflex iliac artery and vein. For the first 14 d of the experiment, 2.4 mL/h of saline solution was infused into the deep circumflex iliac arteries. The infusate for one side contained insulin, delivered at 48 mU/h and estimated to triple the blood insulin concentration in the perfused region. The area of skin supplied by the deep circumflex iliac artery was approximately 250 cm². An area of 100 cm² within the perfused region was used to determine mohair growth. Two weeks after cessation of infusions, perfused areas were shorn. Greasy and clean mohair production from the perfused region was not affected by insulin infusion compared with the side infused with saline (4.57 vs 4.69 and 3.67 vs 3.74 g/100 cm²/28 d for greasy and clean mohair, respectively; $P > 0.10$). Similarly, insulin did not change mohair fiber diameter or length ($P > 0.10$). Plasma glucose concentration was lower ($P < 0.05$) in blood from the deep circumflex iliac vein on the side infused with insulin (57.2 vs 63.4 mg/dL). Blood flow and plasma concentrations of amino acids were not different between treatments ($P > 0.10$). The lack of an insulin effect on mohair fiber growth may be due to insufficient supply of amino acids or, similar to IGF-1, insulin may have limited effects on fiber-producing follicles.

Key Words: Skin Perfusion, Insulin, Mohair

1862 Effects of Preweaning Concentrate Supplementation on Performance of Meat Goats. A. L. Goetsch*, G. Detweiler, and T. Sahl, *E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK*.

Sixty-four Spanish does with 112 Boer x Spanish or Spanish kids (16 singles and 96 twins) were used to determine effects of preweaning feeding of a concentrate-based supplement on preweaning and early postweaning growth. In mid-April, from approximately 6 to 14 wk after birth, animals grazed wheat forage (Phase 1), followed by 5 wk on native grass pasture (Phase 2) and an 8-wk postweaning period with a moderate level of supplemental concentrate (Phase 3). Treatments were no supplementation in Phases 1 and 2 (C), *ad libitum* consumption of a concentrate-based supplement in Phases 1 and 2 (A), no supplementation in Phase 1 and *ad libitum* consumption of supplement in Phase 2 (A-2), and limit feeding of supplement (approximately 1% of live weight, DM) in Phases 1 and 2 (L). Supplement intake averaged 30, 74, 90, 157, and 158 g/d for L and 36, 87, 192, 240, and 229 g/d for A in wk 2-4, 5-6, and 7-8 of Phase 1 and wk 1-2 and 3-5 of Phase 2, respectively; supplement intake for A-2 averaged 171 and 249 g/d in wk 1-2 and 3-5 of Phase 2, respectively. Forage DM mass was 2,474, 2,062, 1,315, 1,434, 2,245, 1,405, and 1,161 kg/ha in wk 1, 3, 5, and 7 of Phase 1 and wk 1, 3, and 5 of Phase 2, respectively. Kid live weight gain was similar among treatments in Phase 1 (108, 131, 119, and 113 g/d), lower ($P <$

0.05) for A than for C and A-2 and lower for L than for C ($P < 0.05$) and A-2 ($P = 0.09$) in Phase 2 (73, 21, 15, and 60 g/d), and lower ($P < 0.05$) for C than for A and A-2 in Phase 3 (44, 67, 90, and 83 g/d for C, L, A, and A-2, respectively). In conclusion, under conditions of this experiment preweaning feeding of a concentrate-based supplement did not enhance kid growth preweaning but generally improved early postweaning growth.

Key Words: Goats, Growth, Supplement

1863 Optimum herd size of small goat holders in Qinba Mountain district in China. J. Luo¹, H. Yao*¹, X. F. Zhao², and H. Y. Yang², ¹Northwest Agricultural University, Yangling, Shaanxi, China, ²Animal husbandry bureau of Xixiang county, Xixiang, Shaanxi, China.

Our objective was to optimize the production and herd size for goat holders in Qinba Mountain district of China using a linear programming technique. The capital input, goat herd structure, grassland condition and economic profit were surveyed on 15 typical small goat holders in 15 locations within Xixiang county of Qinba mountain area, China. Using these survey data from goat holders, resource allocation and management factors were analyzed to identify 12 variables which exhibited a close relationship with goat production at these locations, such as number of bucks, base breeding does, replacement doelings, fattening kids, shed space, grassland area, fertilizer costs, veterinary costs, amount of crop residues and silage, amount of concentrate supplement, labor cost and farm investment in goat production. Parameters of each variable was defined, thereafter, considering net profit as an objective function, applying a linear programming technique to simulate an optimum herd size of small goat holders under differing condition of investment, labor and grazing land. Results suggested that the amount of investment was a major determining factor of herd size under the specific circumstances of Qinba Mountain district, with an average investment, small goat holders possessed approximately 7 hectare pasture could attain the maximum profit if they keep a herd with 20 to 40 does and 1 to 2 bucks. The herd size under two other similar management regimens including bred by either artificial insemination or natural mating in goat herd were also analyzed, the mean profit of investment for three identified conditions were 73.9%, 72.9% and 139.8%, respectively.

Key Words: Optimum Herd Size, Goat Holder, Linear Programming

1864 Growth and survival of kids of three goat breeds during different seasons. S. Wildeus* and T. A. Gipson, Virginia State University, Petersburg, VA.

This experiment evaluated pre-weaning growth and survival in Myotonic, Nubian, and Spanish kids born either in May, December or August. Dams were managed either on a high forage base (HI: moderate stocking rate, rotational grazing), or restricted forage base (LO: high stocking rate, drylot hay feeding). Kids were born on pasture with limited assistance and weaned at 10 wk of age. Seasonal kiddings were replicated and a total of 875 records analyzed in a model that included kidding season, breed, forage base, birth type and sex as main effects. Kids born in August were lighter ($P < .001$) than in May and December (2.31, 2.56 and 2.59 kg, respectively), and Myotonic were lighter ($P < .001$) than Nubian and Spanish (2.31, 2.72 and 2.76 kg, respectively). Myotonic kid birth weights in LO were heavier than in HI, while the other breeds were not different (season x breed interaction: $P < .001$). Birth weights were heavier in HI than LO in May and December, but not August (season x forage base interaction: $P < .001$). Kid survival at birth was higher ($P < .05$) in August than May and December (98.5, 95.3, and 93.8%, respectively). Pre-weaning ADG was higher ($P < .001$) in December (119 g/d), than in May and August (107 g/d), as a result of higher ADG in Myotonic and Spanish, but not Nubian (season x breed interaction: $P < .001$). Pre-weaning ADG was not different between seasons in LO (103 g/d), but higher in December (133 g/d) than May and August (114 g/d) in HI (season x forage base interaction: $P < .05$). Adjusted weaning weights (60 d) reflected pre-weaning ADG and were heavier ($P < .001$) in December than May and August (9.85, 9.07 and 8.79 kg, respectively). Survival to weaning was lower ($P < .001$) in August than May and December (60.4, 76.6 and 70.5%, respectively), and lower ($P < .001$) in Nubian than Myotonic and Spanish (53.8, 73.4 and 79.9%). Data indicate that 'early season' kids born in December

performed similar to spring-born (May) kids, whereas birth weights and survival to weaning was depressed in 'late season' (August) kids.

Key Words: meat goat, season, kid performance

1865 Differences in intake, growth rate and carcass characteristics in young males of three hair sheep and meat goat breeds. S. Wildeus*¹, M. B. Solomon², A. D. Mitchell², J. S. Eastridge², and J. R. Collins¹, ¹Virginia State University, Petersburg, VA, ²Beltsville Agricultural Research Center, USDA, Beltsville, MD.

There is still limited information available on hair sheep (HS) and meat goat (MG) carcass traits. In this experiment 36 postweaning males, representing HS (Barbados Blackbelly: BB, Katahdin: KA, St. Croix: SX) and MG breeds (F₂ Boer Cross: BX, Myotonic: MY, Spanish: SP), were weaned at 9 wk of age, and either left intact or castrated. Animals were allocated to 6 pens by species, stratified by breed and sex class, at 4 mo of age, and fed a diet of moderate quality grass hay *ad libitum* and a corn/whole cottonseed-based concentrate (16% CP) at 2% of BW. Pen intake was measured on d 1-5, d 50-55, d 105-110, and d 148-153 of the trial. At 160 d animals were slaughtered, and carcass characteristics and body composition, using dual energy X-ray absorptiometry, recorded. Data were analyzed in a model with species, breed within species, and sex class as main effects. Forage intake was higher ($P < .001$) in HS than MG (20.8 vs. 16.5 g/kg BW/d). Average daily gain was higher ($P < .001$) in HS than MG (97 vs. 66 g/d), but was not affected by sex class. Within species, ADG was higher ($P < .001$) in KA than SX and BB (129, 85 and 76 g/d, respectively), but was not different in MG breeds. Dressing percent (DP; includes hide), REA and KPH was higher ($P < .05$) in HS than MG (55.9 vs. 54.2%, 10.5 vs. 8.3 cm², and 0.98 vs. 0.66%, respectively), however, weight-adjusted REA and back fat thickness (BF) was not different between species. Within species, KA had higher ($P < .05$) BF and body fat content than BB and SX. In MG, MY had a higher ($P < .001$) DP than BX and SP (56.1, 53.3 and 53.2%, respectively), and a similar KPH in intact and castrate males, while sex classes were different in BX and SP (breed x sex class: $P < .05$). These results confirm differences in growth and carcass characteristics between HS and MG, and point to unique differences in KA and MY within their species.

Key Words: meat goats, hair sheep, carcass traits

1866 Modeling extended lactation curves in dairy goats using grafted polynomials. T.A. Gipson*¹ and G.R. Wiggans², ¹E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK, ²Agricultural Research Service, USDA, Beltsville, MD.

Some dairy goat producers milk their does for an extended period before rebreeding and drying off, but little information is available about the shape of extended lactation curves for goats. To examine the effect of extending lactations upon the shape of the lactation curve, test-day records ($n = 7425$) of 469 does with extended lactations were obtained from USDA/AIPL. Range for days in milk was 419d to 696d with an average of 530d. Number of test days ranged from 12 to 20 with an average of 16 per lactation. Lactations from six breed types (Alpine, LaMancha, Nubian, Saanen, Toggenburg and Experimental) and four parities (first, second, third and fourth or greater) were included. Non-linear regression analysis using several grafted polynomial models was conducted for each animal. The models used were quadratic-linear (QL), quadratic-quadratic (QQ), quadratic-quadratic-linear (QQL), quadratic-quadratic-quadratic (QQQ), quadratic-quadratic-quadratic-linear (QQQL), quadratic-linear-quadratic-quadratic (QLQQ), and quadratic-linear-quadratic-quadratic-linear (QLQQL). The most appropriate model was selected by testing for significant ($P < .05$) reduction in error sums of squares relative to the QL model for each individual animal. A significantly ($P < .01$) higher percentage of selected models were QL than were QQQ, (64% vs. 22%), respectively. The selection of other models was 6% for QQQL, and 3%, 3%, and 2% for, QLQQ, QQ, and QQL, respectively. The QLQQL model was not selected. There were no significant ($P > .10$) breed or parity effects on the distribution of selected models. The median joint point was 300 for QL, and 348 for QQ. Points were 193 and 343 for QQQ; 87 and 147 for QQL; 445, 331, 131 for QQQL; and 287, 185, 57 for QLQQ. A QL grafted polynomial model appears sufficient to model the majority of extended lactation curves in dairy goats.

ASAS Sheep Species

1867 Evaluation of resistance to *H. contortus* in Pelibuey sheep. Antonio Figueroa, Danilo Mendez*, Manuel Berruecos, Rogelio Alonso, and Hugo Perez, *Facultad de Medicina Veterinaria y Zootecnia. Universidad Nacional Autonoma de Mexico.*

The objective of this study was to identify Pelibuey sheep resistant to *H. contortus*. The resistance criterion used was fecal egg counts during an experimental infection of 42 days. Fifty-three Pelibuey lambs of 5 months of age (22 males and 31 females), free of nematodes, were infected with 3,000 larvae of *H. contortus*. Lambs were monitored every week for fecal egg counts (FEC), hematocrit value (HV), plasma protein level (PP), eosinophil counts (EC) and total weight gain (TWG). On day 42 post-infection, lambs were drenched and then evaluated every 28 days for a year under natural infection conditions. The degree of resistance was determined using the average of the last four egg counts during the experimental infection. Data was normalized by a log₁₀ transformation. Statistical analysis of the data was carried out through an analysis of variance. The classification criterion used was the transformed mean minus one standard deviation (criteria equivalent in actual count=1,200 egg counts for males and 1,161 for females). Animals with an average FEC above the criterion were classified susceptible and animals below the criterion were classified resistant. Results showed that 45% of the males and 42% of the females were resistant. Resistant males had an average FEC, HV, PP, EC, and TWG of 752125, 27.6.7, 6.7.1, 2913, and 331.2 kg, respectively. Susceptible males had an average FEC, HV, PP, EC, and TWG of 1072368, 26.2.4, 6.8.1, 23532, and 322.4 kg, respectively. However, no significant differences were found for any these parameters with the exception of FEC ($P < .05$). Resistant females had significantly lower FEC compared to susceptible females (33342 vs 89397, respectively, $P < .05$). No other significant differences were found between resistant and susceptible females. Values for the studied parameters for resistant and susceptible females were: HV, 26.9.5 vs 26.7.5; PP, 7.2.3 vs 6.8.3; EC, 310106 vs 34430; and TWG, 9.6.4 vs 11.85.4, respectively. These data suggest that while variability in FEC exists in Pelibuey, this variability is not strongly associated with differences in HV, PP, EC, or TWG in resistant vs susceptible lambs.

Key Words: *H. contortus*, Resistance, Sheep

1868 Pre-mating nutrition affects the onset and synchrony of oestrus in Merino ewes treated with progesterone CIDR dispensers. SP Quigley*¹, SK Walker¹, PA Speck¹, SR Barritt¹, and DO Kleemann¹, ¹*South Australian Research and Development Institute, South Australia.*

Nutrition is a key factor controlling reproductive performance of the ewe. This study examined the effect of long term nutritional manipulation prior to insemination on the timing and incidence of oestrus in Merino ewes synchronised with controlled internal drug release (CIDR) devices containing 0.3g progesterone. Mature age Merino ewes (n=119) were stratified on liveweight and randomly allocated to 2 nutritional treatments of 1.8 and 0.6 times maintenance requirements (High (H) n=60 and Low (L) n=59, respectively). Ewes were fed a pelleted diet (60% roughage: 40% grain plus additives) for 12 weeks prior to joining. CIDR devices were inserted for 14 days with oestrus observations commencing 24 h after CIDR removal. Oestrus was recorded three times daily (08:00h; 12:00h; 16:00h) on three consecutive days. Ewes were inseminated via laparoscopy using fresh semen collected from a single Poll Dorset ram. Ewe liveweight and condition score between the treatment groups diverged significantly from 8 weeks prior to joining and throughout pregnancy ($p < 0.01$). Low level of nutrition significantly delayed onset of oestrus ($p < 0.01$); oestrus was detected 57 ± 1.8 and 41 ± 1.6 h after CIDR withdrawal in L and H ewes respectively. Better synchronisation of oestrus was observed in H ewes, with 72% of ewes detected in oestrus between 24-48 h after CIDR withdrawal, compared with 23% of L ewes. The percentage of H ewes detected in oestrus over three days tended to be higher (95%) than L ewes (81%) ($p = 0.08$). For ewes detected in oestrus and inseminated, pregnancy rate tended to be higher in H ewes (72.7%) than in L ewes (51.1%) ($p = 0.08$). Litter size did not differ between H (1.55 ± 0.08 fetuses/ pregnancy) and L ewes (1.36 ± 0.1). These results indicate that long term nutritional status of the ewe flock

prior to a artificial insemination/ embryo transfer program has important implications for achieving satisfactory synchronisation of oestrus and ewe fertility.

Key Words: Sheep, Nutrition, Oestrus synchrony

1869 The effects of offering grass or maize silages with a flat rate of concentrate supplementation to pregnant ewes on ewe and lamb performance. T.F. Crosby*, J.V. O'Doherty, P.J. Quinn, J.J. Callan, B. Flynn, D. Cunningham, P. Reilly, and E Massey, *University College Dublin, Belfield, Dublin 4, IRELAND.*

Individually fed twin-bearing ewes (n=64) were offered either grass silage (T1) or maize silage (T2) ad libitum and supplemented with a daily flat rate of 400g concentrates from day 92 of pregnancy until lambing, in order to evaluate pregnant ewe and lamb performance and colostrum yield and quality. Overall daily forage DM intake was lower in the ewes fed grass silage (0.95 vs 1.11kg/ewe; SEM. 0.041; $P < 0.05$) and this was directly reflected in lower ($P < 0.05$) metabolizable energy intake, although these ewes had a higher daily crude protein intake (178 vs 169g/ewe/d; SEM. 3.2; $P < 0.05$). The ewes in T1 gained less liveweight (10.93kg vs 12.90kg; $P < 0.05$), lost more body condition (0.22 vs 0.08; SEM. 0.043; $P < 0.05$) and had a longer gestation length (148.1 v. 146.4 days; S.E.M. 0.34; $P < 0.001$) than the ewes offered maize silage. Despite the difference in gestation length between the two forage types there was no difference in terms of total litter weight (9.87kg vs 9.53kg; SEM. 0.237kg; $P > 0.05$). The type of forage fed had no effect on colostrum yield at 1, 10 or 18 hours post-lambing or on total yield at 18 hours post-lambing ($P > 0.05$). The ewes on the grass silage based diet produced colostrum at 1 hour with a lower total solids concentration than the ewes fed maize silage (410.4 vs 465.1g/l; SEM. 16.39g/l; $P < 0.05$). The forage treatment had no effect on the yield of colostrum total solids, crude protein, IgG concentrations or IgG yield ($P > 0.05$); lamb serum IgG concentration; or the efficiency of IgG absorption in the first 24 h. The type of forage fed to the ewes had no effect on lamb birth weight, lamb weight at five weeks or average daily gain from birth to five weeks ($P > 0.05$). In conclusion the balance of advantages favours the use of maize silage for pregnant ewes especially in relation to ewe weight and body score changes but these advantages did not reflect themselves in colostrum or any of the lamb parameter data measured.

Key Words: Sheep, Silage, Lamb

1870 An evaluation of production systems for early season lamb production. T.F. Crosby, J.V. O'Doherty, P.J. Quinn, J.J. Callan, B. Flynn, and D. O'Shea, *University College Dublin, Belfield, Dublin 4, IRELAND.*

Following lambing, estrus synchronised ewes (n=137) and their lambs (n=239) were divided into four treatment groups and offered diets based on grass (T1), mixed brassica crop (swede/kale mixture) (T2), grass silage (T3), and maize silage (T4) in order to evaluate growth rate and carcass parameters. These forage-based diets were supplemented with concentrates in early lactation. The lambs had access to concentrates from the age of fourteen days and were selected for slaughter between 36 and 42 kg live weight. Concentrate creep consumption was 59.5, 44.9, 55.7, and 59.4 kg for T1-T4, respectively. Lamb growth rate (g/day) from birth until slaughter was 351, 335, 340, and 356 (SEM 9.7) for T1-T4, respectively, with lambs on maize silage growing faster than those on brassicas ($P < 0.05$). Similarly, lamb age at slaughter for T1-T4, respectively, was 98.6, 101.5, 99.9, and 95.0 days (SEM 2.49) with lambs on the maize silage-based diet slaughtered earlier than lambs on either the brassica crop or the grass silage ($P < 0.05$). Mean lamb live weight at slaughter ranged from 38.7 to 40.1 kg with lambs on the brassica treatment being lighter than all other treatments ($P < 0.01$). Carcass weight (kg) for T1-T4 was 18.4, 18.7, 18.6, and 19.0, with dressing percentages of 46.8, 47.5, 47.3, and 48.2 (SEM 0.45), respectively. Lambs on maize silage (T4) had a higher dressing percentage than those on grass (T1) ($P < 0.01$) and grass silage (T3) ($P < 0.05$). Treatment had few significant effects on conformation, fat score, fat colour, or fat hardness. Lambs in T1 and T4 were sold earlier than in other treatments ($P < 0.05$). Ewes offered the maize silage-based treatment had higher DM intakes and lost less weight and body condition ($P < 0.05$). These results show the considerable superiority of maize silage over grass silage for suckling ewes

and their lambs but, in relation to lamb growth rate, the outdoor grass-based system (T1) was equally good. The lower creep intake of the lambs on the brassica-based treatment (T2) was probably a reflection of the highly succulent nature of this crop.

Key Words: Ewe, Lamb, Growth

1871 Feedlot performance, wool production, and carcass characteristics of Merino/Rambouillet wether lambs as affected by breed and dietary forage to concentrate ratios. S. L. Lake*, H. S. Hussein, H. A. Glimp, B. D. Kindred, T. P. Ringkob, and D. W. Holcombe, *University of Nevada - Reno*.

The objective of this study was to determine the effects of sheep breed and finishing diet on feedlot performance, wool production, and carcass characteristics of lambs. Forty lambs (initial BW = 42.47 kg) from two breed (Merino [M]/Rambouillet [R]) combinations (20 each) were assigned at random to 2 dietary treatments in a completely randomized design experiment. Treatments were arranged as a 2 × 2 factorial. The main factors were 2 breed combinations (.5 M-.5 R or .875 M-.125 R) and 2 dietary forage (alfalfa pellets) to concentrate (cracked corn) ratios (i.e., high forage [HF; containing 60% alfalfa] and high concentrate [HC; containing 80% corn]). The diets contained 14.2 and 11.1% CP on DM basis, respectively. The lambs were housed in individual pens in a temperature-controlled room, had ad libitum access to feed, water, and salt blocks, and were harvested at 55.2 kg of BW. No interactions ($P > .05$) between lamb breed and diet were detected for any of the measurements evaluated. Therefore, results of the main factors were summarized. Feedlot performance and wool production were not affected ($P > .05$) by lamb breed but they were influenced ($P < .05$) by diet. Lambs fed the HF diet consumed more DM (1.69 vs 1.38 kg/d), gained faster (.29 vs .21 kg/d), and had higher gain/feed ratio (.171 vs .147). The wool data were derived from evaluation of wool produced in 10 cm × 10 cm midrib patches that were shorn at the beginning of the study. Lambs fed the HF diet produced less grease (8.1 vs 9.9 g) and clean (5.1 vs 6.4 g) wool. Carcass characteristics were not altered ($P > .05$) by the treatments. The only exceptions were less ($P < .05$) kidney, pelvic, and heart fat (2.6 vs 4.0%) and a tendency ($P=.199$) for better yield grade (1.77 vs 1.99) when lambs consumed the HF diet. Results suggest that finishing M/R wether lambs on HF diets (provided by alfalfa pellets) may be beneficial in reducing days on feed, improving efficiency, and producing carcasses with higher yield of boneless cuts. Increasing M genetics from .5 to .875 did not negatively affect lamb

performance. Compared with recommended requirements (NRC, 1985), lambs were either consuming 30% more (HF) or 17% less (HC) CP. It appears that CP requirements of M/R lambs must be equal to or higher than those recommended (NRC, 1985).

Key Words: Sheep, Carcass characteristics, Finishing diet

1872 Comparison of carcass data and ultrasound measures using both cattle and swine standoffs for loin eye area, loin eye depth and external fat in lambs. B.D. Banks*, M.E. Benson, J.D. Cowley, G.C. Good, M.T. Shane, and T.M. Villumsen, *Michigan State University, East Lansing, MI/USA*.

The objectives of this study were to determine accuracy of ultrasound measures for loin eye area (LEA), loin eye depth (LED) and external fat at the 12th rib (BF). Data were collected by real-time ultrasound (Pie 200 SLC, Pie Medical, Tequesta, FL) with cattle (USC) and/or swine (USS) standoffs. Ultrasound measures were compared to carcass measures. Commercial ewe and wether lambs (n=120) born in 1999 and 2000 were harvested at an average weight of 59.36.0 kg. Post-harvest LEA, LED and BF were measured on the carcasses. Actual carcass LEA averaged 17.74 cm² (n=120), USC LEA averaged 18.39 cm² (n=119), and USS LEA averaged 17.87 cm² (n=56). The range in standard deviations across all measurements was 1.94 to 2.26 cm². Actual carcass LED averaged 3.23 cm (n=68), USC LED averaged 2.97 cm (n=68), and USS LED averaged 3.12 cm (n=30). Standard deviations ranged from 0.18 to 0.30 cm. Mean carcass BF was 0.69 cm (n=120), average USC BF was 0.48 cm (n=119), and average USS BF was 0.51 cm (n=56). Standard deviations ranged from 0.13 to 0.25 cm. Correlations between carcass LEA and ultrasound measurements were .30 and .57 for USC LEA and USS LEA, respectively. The correlations between carcass LED and ultrasound measurements were .52 and .68 for USC LED and USS LED, respectively. Carcass BF was correlated with USC BF (0.69) and USS BF (0.78). The linear regression coefficients for carcass LEA on USC LEA and USS LEA were 0.278 ($P<0.01$) and 0.550 ($P<0.01$), respectively. The regression of carcass LEA on USC LED and USS LED were 1.963 ($P<0.01$) and 2.737 ($P<0.01$), respectively. Carcass BF linear regressions on USC BF and USS BF were 1.348 ($P<0.01$) and 1.369 ($P<0.01$), respectively. Both standoffs overestimated the average carcass LEA and underestimated carcass BF. The swine standoff predicted carcass LEA, LED and BF closer to carcass estimates.

Key Words: Sheep, Lamb carcass, Ultrasound

ASAS Swine Species

1873 Lysine requirement of growing (35.1 to 60.5 kg) pigs, when formulated on ideal protein basis. I. Moreira*, M. Kutschenko, A.C. Furlan, A.E. Murakami, E.N. Martins, and C. Scapinello, *Universidade Estadual de Maringá, Maringá-PR, BRAZIL*.

An experiment was performed to determine the optimum lysine (total) level in the diet of the growing pigs when formulated on ideal protein basis. A corn-soybean meal basal diet contained 13% crude protein, 3.4 Mcal of digestible energy/kg and 0.75 % lysine. Treatment diets were supplemented with .15, .30, .45% of lysine to attain dietary concentration of .90, 1.05 and 1.20% lysine (total). Crystalline methionine, threonine and tryptophan were added in all diets to maintain constant ratios of these essential amino acids to the lysine content in each treatment diet. All other nutrients met or exceeded NRC (1998) nutrient requirement of pigs. Thirty-two crossbred pigs with an average body weight of 35.1 kg were blocked by weight and randomly assigned to the four experimental diets for a 28-d growth study. The experiment was a randomized complete design and was conducted in four replicates, with two pigs per experimental unit (pen). Pigs had access to their treatment diets on an ad libitum basis. Pigs were weighed, pen feed intakes determined and individual pig blood samples taken every 14 days. Plasma urea nitrogen (PUN) was determined. Backfat thickness (BF) was obtained using ultrasound on live pigs at the end of the growing phase. Gain:feed and backfat thickness were not affected by lysine levels. The regression models estimated the total lysine (%) requirement to be .90, .89 and 1.03% when average daily feed intake, average daily gain and PUN, are the measurement criteria respectively.

Key Words: Amino Acid Requirement, Ideal Protein, Pigs

1874 Substitution of Corn to Coffee Hulls in a Isoenergetic Diets for Growing and Finishing Pigs. E. T. Fialho*^{UFLA}, V. Oliveira^{UFLA}, J. A. F. Lima^{UFLA}, and R.T. Freitas^{UFLA}, ¹*Universidade Federal de Lavras - UFLA/BRAZIL*.

A metabolism assay and a performance trial were carried out at the University of Lavras (UFLA) in Brazil in order to evaluate the technical and economical viability of substitution of corn with Coffee Hulls (DM 86.7%; CP 10.2%; FDN 55.0% and 2500Kcal DE/Kg) in isoenergetic growing and finishing pig diets. The metabolism assay was conducted utilizing 24 crossbred (LDxLW) barrows with 12 in the growing phase (34.8 Kg) and 12 in the finishing phase (60.7 Kg) which were randomly assigned to a metabolism cage with six replicates per phase. In the performance trial a total of 96 crossbred (LDxLW) barrows and gilts with mean initial weight of 34.4 Kg were utilized. The experiment was in a randomized block design with four treatments and six replicates with pigs distributed in a pen with four pigs (2 barrows and 2 gilts). The treatments consisted of the inclusion of Coffee Hulls (CH) at 0.0;5.0;10.0 and 15.0%, replacing corn in isoenergetic diets (16% and 14% CP and 3350 Kcal DE/Kg) for growing and finishing phases, respectively. Increasing the level of CH decreased linearly ($P<0.01$) the digestibilities of nutrients as well as energetic values (DE and ME) of the diets. The performance assay showed that weight gain decreased linearly ($Y=876.3-13.17R=0.932$) and feed intake decreased linearly ($Y=2.685-34.26R=0.899$) with increasing CH. Considering the price of corn and CH in January/2001 the use of Coffee Hulls was technically

and economically viable at levels up to 5% in growing and finishing pig diets.

Key Words: pigs, metabolism assay, alternative feedstuffs

1875 Effect of deletion of vitamin and trace mineral premixes from diets on daily gain, feed:gain ratio, backfat thickness, red blood cell count in finishing pigs. S. C. Lee^{*1}, C. E. Lee², and K. I. Kim¹, ¹*Cheju National University, Cheju, Rep. of Korea*, ²*Cheju Agr. Exp. Station, RDA, Cheju, Rep. of Korea*.

A study was done to determine the effect of deletion of vitamin and trace mineral premixes from diets on growth and feed:gain ratio, hemoglobin content, hematocrit and red blood cell count in finishing pigs. Three replicates of 5 pigs each (average weight, 70 kg) were assigned to a control (with complete premixes), 50% or 100% deletion of the premixes and fed to market weight. They had free access to feed and water. Average daily gain \pm SEM was 0.78 ± 0.04 , 0.73 ± 0.03 and 0.74 ± 0.05 kg for control, 50% deletion and 100% deletion over a 7-week feeding period, respectively. Feed:gain ratio, and carcass backfat thickness (mm) were 3.86 ± 0.05 , 3.90 ± 0.20 and 3.96 ± 0.05 , and 23.7 ± 2.49 24.5 ± 4.68 and 25.3 ± 4.86 for control, 50% deletion and 100% deletion, respectively. Hemoglobin content (g/100 mL blood); hematocrit (volume %); and red blood cell count (millions/mL) were 14.2 ± 0.7 , 13.4 ± 1.1 and 13.7 ± 1.3 ; 44.5 ± 2.0 , 42.6 ± 3.6 and 44.2 ± 4.0 ; and 734 ± 42 , 697 ± 79 and 719 ± 69 for control, 50% deletion and 100% deletion, respectively. All of these measurements were not different ($P > 0.05$) among the dietary groups. These findings together with others' clearly demonstrate that supplementary vitamins and trace minerals are not necessary for finishing pig diets.

Key Words: Vitamins, Minerals, Pigs

1876 Fatty acid polyunsaturation of boar semen: Positive effects on gilt reproduction. P.C Penny^{*1}, R.C Noble¹, and A. Maldjian¹, ¹*JSR Healthbred Ltd, Southburn, Driffield, YO25 9ED, UK*.

The major differentiated regions of the spermatozoan cell, display their own unique lipid compositions involving a high degree of polyunsaturation. Idealisation of the polyunsaturation profile of boar spermatozoa by nutritional supplementation (ProsperrmTM), has demonstrated highly beneficial effects on spermatozoa characteristics. The aim of this study was to determine if gilts inseminated with spermatozoa from boars with enhanced polyunsaturated spermatozoa composition would enhance female reproductive output beyond standard boar spermatozoa. Thirty five boars were allocated to the study, with four hundred and seventy eight gilts (JSR Genepacker) being randomly allocated to two insemination treatments, either standard or optimised polyunsaturated semen (post eight week spermatozoa synthesis). All gilts were artificially inseminated twice (75ml, 2.5 billion spermatozoa. Insemination timing schedule (days) either d1+2, d2+3 and d3+4 was balanced between semen treatments. Significant positive effects were observed for conception rate (90 vs. 83 %, $P < .05$), born alive (10.6 vs. 10.2, s.e.d. 0.19, $P < .05$) and overall fecundity, number of piglets born alive per 100 services (954 vs. 846, s.e.d. 19.5, $P < .001$) in those gilts inseminated with enhanced polyunsaturated spermatozoa. Polyunsaturated fatty acids which are concentrated in the cell membrane and tail region of spermatozoa, have been shown to play a pivotal role in both spermatozoa capacitation and the interaction between spermatozoa cell membrane and uterine surface. The increased female reproductive efficiency demonstrated here by utilising enhanced polyunsaturated spermatozoa, can be associated with improved spermatozoa characteristics and survivability properties during the critical time window from semen insemination to fertilisation.

Key Words: Boar, Polyunsaturation, Spermatozoa

1877 Effect of docosahexaenoic acid (DHA) and cryopreservation on boar spermatozoa. A Maldjian¹, P.C Penny^{*1}, S Cerolini², and R.C Noble¹, ¹*JSR Healthbred Ltd, Southburn, Driffield, YO25 9ED, UK*, ²*Istituto Zootecnico, Via Celoria 10, 20133 Milano, Italy*.

Lipids present within boar spermatozoa play a key role in physiological and structural formation. Cryopreservation of boar semen is not routinely used due to variable spermatozoa survival rates. Changing specific fatty acids within the spermatozoa could deliver both fresh and frozen

benefits. The aim of this study was to investigate the effect of providing a supplement containing docosahexaenoic fatty acid (DHA) plus antioxidants (PropsermTM) on the fresh quality of boar spermatozoa and subsequent cryopreservation of such derived spermatozoa. Fourteen boars were randomly allocated to either a standard boar diet or standard diet + nutritional supplement (ProsperrmTM), for 16 weeks. Both fresh and thawed samples of normal and DHA manipulated spermatozoa were assessed for motility and viability. Ejaculate concentration and fatty acid profile were assessed on fresh spermatozoa only. Samples were frozen using the Westendorf procedure (1975). The level of DHA increased from 28.1 % to 43.3 % of total fatty acids ($P < .01$) in spermatozoa from supplemented boars. Sperm concentration was also significantly higher (571 vs. 695 million per ml; $P < .05$) in boars receiving the supplement. Following cryopreservation and thawing sperm quality parameters were similar for normal and DHA manipulated spermatozoa. DHA supplementation of boars provided a major benefit for improving fresh spermatozoa quality. Altering other fatty acids in-conjunction with DHA may be required to improve cryopreservation of boar spermatozoa.

Key Words: Boar, Docosahexaenoic, Spermatozoa

1878 Response of weaned pigs housed in large groups to alternative feeding strategies. P.C Penny^{*1} and S Tibble², ¹*JSR Healthbred Ltd, Southburn, Driffield, YO25 9ED, UK*, ²*SCA Iberica S.A., Mequinenza, Spain*.

The uptake by pig producers of large group (LG) weaning systems provides complex nutritional challenges. Defining an appropriate nutritional strategy to accommodate the extensive weaning weight variation within LG is not easy. The aim of this study was to investigate specific nutritional feeding regimes to maximise the overall performance of weaned pigs housed in LG. A total of 1300 weaned piglets were used in a randomised block design involving two treatments (group size 130). 1. Fixed feeding regime of four diets, each offered for a specific number of days (FX). 2. Choice feeding regime, same four diets but offered in paired combinations over time (CH). Feeder allocation, feeder type and water availability were standardised. All pigs were weighed individually at weaning, d 7, 14, 21, 28 and 35. Average daily gain (ADG) during d0-7 was significantly reduced for FX compared to CH, 0.117 vs. 0.143 kg ($P < 0.01$). From d8-14 ADG for FX was significantly higher than CH, 0.340 vs. 0.315 kg ($P < 0.01$). Live weight at d35 was significantly lower for FX compared to CH, 19.9 vs. 20.7 kg ($P < 0.01$). Pigs on CH showed clear evidence of being able to choose between diets offered. This study demonstrates positive nutritional solutions for improving the performance of weaned pigs in LG. Further work is necessary to synergistically combine specific attributes from both FX and CH feeding strategies.

Key Words: Large group, Nutrition, Pig

1879 Increased progeny performance by elevating nutrient intake to sows during gestation. P.C Penny^{*1}, M.A Varley², and S Tibble³, ¹*JSR Healthbred Ltd, Southburn, Driffield, YO25 9ED, UK*, ²*SCA Nutrition Ltd, Thirsk, UK*, ³*SCA Iberica S.A., Mequinenza, Spain*.

Previous work has demonstrated a positive effect on progeny performance from increasing nutrient intake to sows between d 28-56 of gestation. This first in-field experiment was undertaken with limited numbers and although results obtained were positive, further data is necessary to deliver producer acceptance. The aim of this study was to extrapolate and confirm the effectiveness of implementing increased nutrients d28-56 and the effect of offering two diets to derived progeny during the growth phase (2x2 factorial design). Forty eight multiparous sows were randomly allocated between two treatments, Standard (ST) 2.5 kg/d or Elevated (EL) 5.0 kg/d. Pigs from each sow were housed in groups of twelve, received identical nutrition and were weighed on d 57, 85, 127 and 157. Two diets differing in lysine content (1.05 vs. 1.25 %) were offered to ST and EL progeny during d85-127. Quantity of feed consumed during gestation was lower ($P < 0.01$) for ST than EL. ST progeny produced a significantly lower average daily gain from d 85-127 ($P < .05$) compared to EL progeny (0.866 vs. 0.910 kg). This was also evident for both diets. Food conversion for ST progeny was substantially increased (2.201 vs. 2.060, $P < .05$) compared to EL, again represented by both dietary treatments. These results confirm that increased maternal

nutrients, d28-56, provides enhanced progeny performance and suggests the possibility of reducing the nutrient density of the diet offered.

Key Words: Sow, Gestation, Performance

1880 Effect of storage and pelleting temperature on the activity of bacterial alkaline endoprotease (E.C. 3.4.21.14), Alpha D-(1,4) amylase (E.C. 3.2.1.1) and combination of both enzymes. I Prez-Portabella¹, J Sol, and E Roura*, ¹Lucta, s.a.

The objective of this study was to examine the ability of bacterial alkaline endoprotease (E.C.3.4.21.14), Alpha D-(1,4) amylase (E.C.3.2.1.1) and the combination of both enzymes (Luctazyme Pro-Pig[®]) to withstand storage and exposure to moist heat. In experiment 1 enzymes were incubated in a water bath at different temperatures for 1 minute simulating pelleting heat conditions (table). In experiment 2 protease stability in the combined product at a three different storage conditions (5C, 22C and 40C) was assessed. Enzyme activities were determined using the methods developed by Lucta, s.a. after modification of previously published laboratory procedures. One unit of amylase activity is defined as the amount of enzyme which liberates 1 mmole of reducing sugars from potato starch per minute at pH 7 and 40C. One unit of protease activity is the amount of enzyme which liberates 1.5 mg/ml of L-tyrosine from casein per minute at pH 7 and 37C. The effect of different heat treatments on protease and amylase activity are shown in table 1 and 2.

Both, the endoprotease and the alpha-amylase, are highly stable even at 80C when assayed separately (84% and 90.5% of residual activity respectively) and in combination (80% and 84%). Loss of endoprotease activity in combination with alpha-amylase after 6 month storage was 18% at 40C, 4.5% at 22C and 3% at 5C. It is concluded that the combination of endo-protease and alpha-amylase is stable to moist heat and a 6 month storage at 40, 22 and 5C.

% protease activity	50 C	60 C	70 C	80 C
Bacterial alkaline endoprotease	99.0	1.0	95.5	2.5
Combination of both enzymes	99.0	1.0	96.0	1.5
% amylase activity	99.0	1.0	94.0	2.0
Alpha D-(1,4)amylase	99.0	1.0	94.0	2.0
Combination of both enzymes	98.0	2.0	92.0	1.0

Key Words: Alkaline endoprotease, Alpha-amylase, Stability

1881 *Saccharomyces cerevisiae* for breeding sows in a Parvoviral challenge. V. G. Perez¹, M. L. Angeles², A. M. Anaya², and J. A. Cuaron², ¹FES-C, UNAM, ²C. N. I. Fisiología y Mejoramiento Animal, INIFAP. Queretaro, Mexico.

A total of 94 sows were challenged by a management induction of a parvoviral outbreak in 50% of the herd at breeding. Parvovirus surviving piglets are weaker and more susceptible to secondary infection; therefore the disease was used as a challenge to possible protective effects on productivity by a live yeast strain. Starting at d-30 of gestation sows were randomized to 2 treatments: Control (CTR) and the addition of 3 kg/ton of feed of live *Saccharomyces cerevisiae*, strain 47 (S47); treatments identity was conserved upon weaning. Parity (first litter gilts, mature sows, 2-5, and old 6+ farrowings) was included in a factorial arrangement. Parvovirus infection was confirmed by clinical signs, including number of piglets born alive. Challenged sows farrowed 7.6 live pigs and weaned 5.5 piglets vs. 10.7 and 9.1 in healthy animals (P<.01). Litter size effects were those expected and no interaction was detected (P>.23) with S47 addition or parity. Feed intake during lactation was 5.2 kg/d (P>.32), but yeast addition resulted in heavier litters at weaning (P<.01): 53.6 vs. 46.5 kg, for a mean litter size of 7.3 piglets after a lactation period of 24-d. Sow parity and S47 interacted (P<.11) in sow lactation wt. loss: first litter gilts in S47 lost 20.4, while CTR gilts 6.9 kg; sows in all treatment combinations lost 16.7 kg. Milk protein and fat was analyzed at d-10 of lactation and mean composition was similar: CP, 9.7 and fat, 7.3% (P>0.8). However, total milk CP and ME yield was calculated higher in S47 fed sows (P<.05). No differences (P>.25) were observed in subsequent reproductive performance, including pigs at parturition. The effect of S47 was the induction of greater

(by 15%) litter weaning weight; live yeast in the dam's diet did not protect piglets from Parvovirus side effects, but may be favoring a better metabolic response for milk synthesis.

Key Words: Yeast, Lactating sows, Parvovirus

1882 *Saccharomyces cerevisiae* for lactating sows in a septic environment. V. G. Perez¹, S. Solorio², A. Juarez³, J. Becerri³, E. O. Castaneda-Silva⁴, and J. A. Cuaron⁵, ¹FES-C, UNAM, ²PAIEPEME, A.C., ³Grupo Delta, S.A., ⁴Nutrimentos Concentra, S.A. de C.V., ⁵C. N. I. Fisiología y Mejoramiento Animal, INIFAP. Queretaro, Mexico.

In a commercial farm suffering several infectious diseases (among others PRRS), a total of 322 sows were used to conduct an experiment in two phases. Phase 1 was supervised feeding to ensure *ad libitum* intake, while in Phase 2, feeding was done by laborers applying the feeding method as a routine. Treatments were the addition or not of 2 kg/ton of a live culture of *Saccharomyces cerevisiae* strain SC47 (S47), to the lactation diet. Productive performance was measured during lactation and re-breeding. Experimental lactation diets were offered from gestation d-100, at 2 kg/sow/d. From farrowing sows' feed allowance was increased by .5 kg/d until *ad libitum* intake. Sows' parity group (1st, 2nd, 3rd and greater than 5 parities) was included in the model as a factor. Overall, number of piglets born alive was 10. In Phase 1, S47 fed sows had greater (P<.08) daily feed intake (5.72 vs. 5.45 kg) during the 16-d lactation period. Sows fed S47 weaned heavier (P<.02) litters (45.84 vs. 42.71 kg) and exhibited less (P<.01) piglet mortality (7.01 vs. 12.83%). Sow wt. change during lactation was similar (P>.25) between dietary treatments (mean of -3.5 kg). In Phase 2, mean daily feed intake was similar (P>.8) between dietary treatments, but differences in litter wt. at weaning were maintained (P<.05; 44.9 vs. 42.8 kg), resulting in greater (P<.01) sow wt. loss: 6.77 vs. 2.53 kg. In both phases, sow parity and S47 showed (P>.2) no interactions for any of the response criteria. Days to 1st estrus, conception rate and prolificacy to the following farrowing were unaffected (P>.7). It is inferred that the greater litter wt. gain in yeast fed animals was a consequence of a better metabolic status, possibly by enhancing immune responsiveness of the sows to acute sub-clinical challenges.

Key Words: Yeast, Lactating sows, Health status

1883 *Saccharomyces cerevisiae* for growing-finishing pigs in a septic environment. V. G. Perez¹, S. Solorio², A. M. M. Martinez³, E. O. Castaneda-Silva⁴, and J. A. Cuaron⁵, ¹FES-C, UNAM, ²PAIEPEME, A.C., ³CNID-Microbiología, INIFAP, ⁴Nutrimentos Concentra, S.A. de C.V., ⁵C. N. I. Fisiología y Mejoramiento Animal, INIFAP. Queretaro, Mexico..

A total of 630 growing-finishing barrows and gilts (mixed in similar proportions) of an avg. initial wt. of 41.7±7 kg (a covariable) were used in a single experiment in which pigs were weaned and raised to initial wt. from sows fed diets containing 2 kg/ton of a live culture of *Saccharomyces cerevisiae*, strain SC47 (S47). In three treatments, S47 was kept in the diets to starting wt. (W40), up to 70 kg BW (W70) or to market wt. (105±6 kg), no withdrawal (NOW). The experiment was a RCB, being blocks 2 identical open front buildings in which pigs were housed in pens of 21 head. There were 10 pen replications per treatment. In all cases, antibiotics were used in feed up to 70 kg BW, as recommended by the resident veterinarian. Feed intake was measured daily and body wt. gain by weighing pens every 14-d. Real time ultrasound measurements (backfat and muscle depth at P2) were recorded initially and in 28-d intervals. Clinical observations were recorded and animals losing BW in two consecutive weighings were removed and counted as mortality. Average feed intake was 2.42 kg/d and no differences were noted (P>.7) between treatments. However, BW gain showed differences (P<.07): W40, .718 < W70, .747 and NOW, .762 kg/d and gain:feed was: W40, .29 < W70, .31 and NOW, .32 (P<.03). Noted differences (P<.05) in carcass composition were on P2 backfat at the last rib, which paralleled daily BW gain: W40, 15.4 < W70, 16.4 < NOW, 17.6 mm. During the experiment an outbreak of complicated mycoplasmosis resulted in high mortality during a 2 week span, starting at about d-125 of age. Final mortality rate was: W40, 6.54 > W70, 3.64 and NOW, 2.32% (P<.08). Live S47 yeast in feed possibly conferred better resistance to disease, provided that the culture was present in the diet at time of challenge.

Key Words: Yeast, Growing pigs, Health status

1884 Molecular typing of hemolytic *Escherichia coli* isolated from swine. D. Parrott*¹, T. Rehberger¹, and M. Holt², ¹Agtech Products, Inc., Waukesha, WI, ²Varied Industries Corporation, Mason City, IA.

E. coli is known to cause edema disease and coliform gastroenteritis in swine leading to an important economic loss and mortality between weaning and market. Understanding the genetic diversity between isolates is an important aspect when trying to prevent and treat this disease. Forty-eight hemolytic *E. coli* isolates were obtained from animal diagnostic laboratories in Iowa, Oklahoma, Arkansas, Georgia, Indiana, and Texas as a causative agent in infected swine herds presenting with diarrhea or edema disease. All isolates were biochemically tested to confirm their identification. The isolates were genetically analyzed using pulse-field gel electrophoresis (PFGE) and random amplified polymorphic DNA analysis (RAPD). PFGE was performed using chromosomal DNA embedded in agarose beads and digested with *Xba* I. PFGE analysis classified isolates into 22 genotypes with no genotype containing more than four isolates. RAPD was performed using two 10-base pair oligonucleotide primers. RAPD analysis with the first primer classified isolates into 15 genotypes with no genotype containing more than five isolates. RAPD analysis with the second primer classified isolates into 10 genotypes with no genotype containing more than eight isolates. The classifying of swine *E. coli* into 10-22 different genotypes demonstrates the genetic variability within hemolytic *E. coli* isolated from infected swine herds. Both PFGE and RAPD analysis are useful techniques for isolate typing, with PFGE being the more discriminatory method.

Key Words: Swine *E. coli*, Pulsed-field gel electrophoresis, Random amplified polymorphic DNA analysis

1885 Effect of three dietary growth promoting additives on performance of nursery pigs. B. P. Corrigan*¹, B. F. Wolter¹, M. Ellis¹, and S. Moreland², ¹University of Illinois, Urbana, IL/USA, ²Braes Feed Ingredients, Wheeling, IL/USA.

This study was carried out over a 4-wk period to investigate the impact of dietary additions of 3 growth-promoting agents on growth performance of nursery pigs. A randomized-block design was used with four treatments and fifteen replicates per treatment, blocked by weaning date. The treatments were: 1) Control (no additive); 2) Zinc oxide (to provide 3000 ppm added zinc); 3) Antibiotic CSP 250[®] (at 0.25% of the diet to provide 110 mg of chlortetracycline, 110 mg of sulfamethazine, and 55 mg of penicillin per kg); 4) ApexTM 3050 (at 0.10% of the diet). ApexTM 3050 is a blend of specific plant extracts, mixed herbs, essential oils and AllinexTM, a natural form of alliin. A total of 360 crossbred pigs were weaned at 21 ± 1.2 d of age and allotted to treatment groups (mixed-sex) of 6 pigs on the basis of weaning weight, sex, and litter. Pigs were given ad libitum access to feed and water. A two-phase feeding regimen was used with the Phase I diet (3438 kcal/kg ME, 23.8% CP, 1.63% lysine) fed as a pellet for the first two weeks and the Phase II diet (3421 kcal/kg ME, 22.68% CP, 1.46% lysine) fed as a meal in weeks 3 and 4. Morbidity (pigs removed due to poor health or lameness) was higher for the control compared to the other treatments (17.7 vs 5.6 vs 3.3 vs 3.3 %, for the Control, Zinc oxide, CSP 250[®], and ApexTM 3050, treatments, resp., P<0.01). Two pens of pigs on the control treatment were removed from the study because of high levels of morbidity and the data from these pens were not included in the growth performance analysis. Over the 4-week study period, ADG (229 vs 324 vs 277 vs 259 g, SE 7.8 g, resp., P < 0.05), ADFI (392 vs 469 vs 430 vs 408 SE 10.8 g, resp., P<0.05), and G:F (0.66 vs 0.76 vs 0.72 vs 0.71 SE 0.015 g/g, resp., P<0.05) were lowest for the control and highest for the Zinc oxide treatment, with the other two treatments generally being similar and intermediate for these traits. These results suggest the growth promoting additives evaluated in pigs weaned at 21 d of age were effective in reducing morbidity and increasing growth performance for 4-wk post-weaning.

Key Words: Pigs, Weanling, Growth

1886 Effect of iron supplementation and dietary iron source and level on bioavailability of iron in weanling pigs. B. K. Anderson*¹, N. R. Augspurger¹, M. Ellis¹, and D. E. Nuzback², ¹University of Illinois at Urbana-Champaign, ²Albion Laboratories, Inc.

The effect of iron (Fe) supplementation and dietary Fe source on Fe bioavailability was determined by hemoglobin (Hb) depletion and use of a slope-ratio assay. Ninety Fe-deprived piglets (Hb 5.17 ± 1.21 g/dL) from 11 litters were used in a 2 × 3 × 5 factorial design, the factors being Fe supplementation level, dietary Fe source and dietary Fe concentration. Piglets were randomly allotted at birth to one of two Fe supplementation levels, 0 or 30 mg Fe via Fe dextran. Injections were administered on d1 with all piglets receiving either 1 ml saline or 1 ml Fe dextran 30 mg Fe/ml. At weaning, pigs were blocked by Fe supplementation level, then randomly allotted across 13 dietary treatments comprised of 4 levels of 3 dietary Fe sources and a common control. Diets were based on a common basal diet employing dried skim milk and corn to yield 27 mg/kg of iron. Twelve diets were formulated from aliquots of the basal diet to contain 25, 50, 75, and 100 mg Fe/kg iron from either ferrous sulfate, an Fe-amino acid chelate or a combination of ferrous sulfate and chelated product mixed in a 70:30 ratio (Fe concentration). Performance measures (ADG, ADFI, and G:F) were recorded individually for all piglets. Blood Hb concentration was determined at the start and end of the 3-wk feeding period during which pigs were offered feed and water ad libitum. Estimates for Fe bioavailability of both Fe chelate and ferrous sulfate/chelate combination were based on the ratio of the regression slopes of blood Hb levels on dietary Fe intake for both sources vs. ferrous sulfate. Those values were calculated to be 98.5% for the chelated product and 107.6% for the ferrous sulfate/chelate combination. These values are generally higher than previously reported for iron complexes.

Key Words: pigs, iron, bioavailability

1887 The response of starting pigs to increasing levels of dietary lysine, when formulated on ideal protein basis. I. Moreira*, A.L. Fraga, A.C. Furlan, A.O. Bastos, R.P. Oliveira, and D. Paiano, *Universidade Estadual de Maringa, Maringa-PR Brazil.*

A trial was carried out to evaluate the effect of increasing lysine levels (LYS) in the diet of starting pigs when formulated on ideal protein basis. A corn-soybean meal basal diet contained 13.1% crude protein, 3.4 Mcal of digestible energy/kg and 0.80% lysine. Treatment diets were supplemented with .2, .4, or .6% lysine to attain dietary concentrations of 1.0, 1.2 and 1.4% lysine (total). Crystalline methionine, threonine and tryptophan were added in all diets to maintain a constant ratio of these essential amino acids to the lysine content. All other nutrients met or exceeded NRC (1998) nutrient requirements of pigs. Sixty-four crossbred pigs with an average body weight of 15.3 kg were blocked by weight and randomly assigned to the four experimental diets for a 26-d growth study. The experiment was a randomized complete block design and was conducted in eight replicates with two pigs per pen (experimental unit). Pigs had access to their treatment diets on an ad libitum basis. Pigs were weighed, pen feed intakes determined and individual pig blood samples taken at 14 days and at the end of experimental period. Plasma urea nitrogen (PUN) was determined. Neither PUN nor average weight gain was altered (P≥.05) by lysine levels. Increasing lysine levels resulted in linear (P≤.05) responses in average feed intake (AFI = 1.378331 - .1905×LYS) and feed:gain (F:G = 2.16182 - .174625×LYS).

Key Words: Ideal Protein, Plasma Urea Nitrogen, Starting Pig

1888 Effect of a GnRH-analogue at estrus on reproductive performance of gilts. J.A. Romo*¹, R. Barajas¹, and M.A. Luque¹, ¹FMVZ-Universidad Autonoma de Sinaloa (Mexico).

With the objective of determining the effect of the application of an analogue of gonadotropin releasing hormone (GnRH-A) at estrus on reproductive performance of gilts, two experiments were carried out. Experiment 1. One hundred seventy four hybrid gilts (YLHD; 1-5 parities) that had shown estrus between December and February (cool season) were used in a randomized design experiment. Gilts were designated to receive one of two experimental treatments: 1) Injection (im) of 50 µg of GnRH-A at first acceptance of a boar (GnRH-A; n=84); or 2) Injection of 2 mL of water (control; n=84). Experiment 2. One hundred thirty two hybrid gilts (YLHD; 1-5 parities) having shown estrus between June

and September (hot season) were used in a randomized design experiment, and received similar treatments as in experiment 1 (GnRH-A, n=70; and control, n=62). In experiment 1, farrowing was between March and June. GnRH-A application had no effect on the number of total piglets born (11.35 vs. 11.44) or the number of liveborn piglets (10.73 vs. 10.78). Fertility was similar (P>0.10) across treatments (90% vs. 85.71%). In experiment 2, farrowing was between October and January. GnRH-A injection had no effect (P>0.10) on the num-

ber of total piglets born (11.25 vs 11.20) or number liveborn (10.14 vs 10.22). Fertility of gilts receiving GnRH-A (91.43%, 64/70) and control gilts (85.48%, 53/62) was not different (P>0.10). It is concluded that injection of GnRH-A at service time does not affect the reproductive performance of gilts.

Key Words: GnRH, Reproduction, Gilts

ASAS Horse Species

1889 Temporal variables of the flat walk of the Tennessee Walking Horse weanling. K.M. Holt*¹ and M.C. Nicodemus¹, ¹Mississippi State University, Mississippi State, MS/USA.

Limited research has been done on gaited horses, particularly concerning gaited weanlings. During the first few years, proper gait development for the gaited horse is very critical. This study describes the stride variables of the flat walk for 4 Tennessee Walking Horse weanlings. Frame-by-frame analysis was done to measure the following stride variables: stride duration, fore and hind stance durations, diagonal and lateral step intervals, and percentage of limb support. Four strides of a natural, consistent flat walk were measured for each weanling. The flat walk was determined to be a symmetrical, four-beat stepping gait that alternated between periods of tripod and bipedal limb support. The majority of the stride was spent in a stance phase with a similar percent of stance for both the fore and hind limbs. Weanlings 3 and 4 had a longer diagonal than lateral step interval and longer lateral than diagonal bipedal support indicating these gaits had an irregular rhythm with lateral couplets. Weanling 2 had the most even gait by demonstrating similar lateral and diagonal step intervals, lateral and diagonal bipedal supports and fore and hind stance durations. These stride variables will assist in the better understanding of how the gaits of the gaited horse develop with age. The temporal variables of these weanlings will be measured throughout aging and training to track the development of the flat walk.

Table 1. Mean values (SD) for the stride variables in the individual weanlings and group mean (SD) values.

	Wean-ling 1	Wean-ling 2	Wean-ling 3	Wean-ling 4	Ave.
Stride Duration (ms)	908(42)	1133(96)	1150(72)	1133(64)	1081(121)
Fore Stance (ms)	542(42)	696(40)	708(57)	688(61)	659(78)
Hind Stance (ms)	546(32)	696(59)	696(69)	708(64)	662(80)
Lateral Step Interval (ms)	425(35)	584(99)	392(43)	409(66)	453(79)
Diagonal Step Interval (ms)	464(62)	534(50)	742(97)	709(92)	613(92)
Lateral Bipedal Support (%)	35(4)	27(6)	43(6)	43(6)	37(8)
Diagonal Bipedal Support (%)	25(2)	27(3)	13(1)	11(3)	19(6)
Tripedal Support-2 Hind (%)	20(4)	23(1)	21(2)	25(3)	22(3)
Tripedal Support-2 Fore (%)	19(3)	23(5)	23(3)	21(6)	22(4)

Key Words: Gaited weanlings, Equine locomotion, Temporal variables

1890 In vitro fermentation characteristics of vegetative and mature grasses by equine fecal inoculum. H. S. Hussein*, H. Han, J. P. Tanner, and A. A. Cirelli, University of Nevada - Reno.

The objective of this study was to determine the effects of forage species and stage of maturity on digestibility of DM and OM and on VFA production after in vitro incubation of .5 g DM of each substrate with equine fecal inoculum. Three horses (replications) were maintained on a diet containing oat-alfalfa cubes (i.e., 70% alfalfa hay and 30% oat hay) and were used as donors of fecal inocula for the in vitro fermentation. In a completely randomized design, the treatments were arranged as a 4 × 2 × 4 factorial. The main factors were 4 forage species (bromegrass [BG; *Bromus inermis*], orchardgrass [OG; *Dactylis glomerata*], ryegrass [RG; *Lolium perenne*], and tall fescue [TF; *Festuca arundinacea*]), 2 stages of maturity (vegetative [V] or mature [M]), and 4 incubation times (i.e., 6, 12, 24, and 48 h). Interactions (P < .05) were only detected between forage species and stage of maturity for DM and OM digestibilities. Digestibility of DM (across incubation times) was highest (35.0%; P < .05) for OG-V and lowest (29.9%; P < .05) for RG-M. Digestibility of OM (across incubation times) was highest (41.0%; P < .05) for BG-V and lowest (33.3%; P < .05) for RG-M. With the exception of acetate, forage species had no effect (P > .05) on individual or total VFA concentrations. Acetate concentration was highest (9.32 mM; P < .05) for RG and lowest (8.03 mM; P < .05) for TF. Concentrations of acetate, propionate, butyrate, and total VFA were higher (P < .05) for vegetative (9.14, 2.64, .50, and 12.98 mM, respectively) than for mature (8.13, 2.25, .30, and 11.26 mM, respectively) forages. Evaluation of the 4 forage species indicated that OM digestibility was lowest (P < .05) for RG than for BG, OG, or TF (36.4, 39.8, 39.6, and 38.5%, respectively). The corresponding values for total VFA (12.7, 11.7, 12.7, and 11.5 mM, respectively), however, were not different (P > .05). Therefore, horses may be able to utilize BG, OG, and TF more efficiently than RG.

Key Words: Horses, Forages, In vitro digestibility

1891 Environmental factors affecting racing time in Brazilian Thoroughbred horses in Cristal hippodrome. Rodrigo Taveira* and Marcilio Mota, ^{Unesp}Universidade Estadual Paulista.

The aim was to study environmental factors that affect the racing time of Thoroughbred that won races in the classical calendar at the Cristal hippodrome, State of Rio Grande do Sul, Brazil. The data used in this study were provided by the Study Book from the Brazilian Association of Race Horse Breeders (ABCCC) and included 1139 finishing times from 420 animals that won 100 different kinds of races taken place from 1974 to 1998. The analyses of information was carried out using the GLM procedure of the Statistical Analyses Systems (SAS, 1996). Race year (1974 to 1998), track condition, grade (5 levels), condition (sex and age combination) and distance (700 to 3000 meters) were the fixed effects considered in the linear model. The fastest time have been provided by the animals that was running on light turf and group I (the most important of the grades). There are not significant difference between the different kinds of sex and age combination and year of race. The quadratic regression of time on distance has shown decrease in average speed of 0.92 m/s, when racing distance goes from 1000 m (16.69 m/s) to 2000 m (15.77 m/s), and 0.49 m/s from 2000 m to 3000 m (15.28 m/s).

Key Words: Thoroughbred, Race, Time

1892 Environmental factors affecting the racing time of Quarter Horses in Brazil. Marcilio Mota and Rodrigo Taveira*, *Unesp Universidade Estadual Paulista.*

The aim of this paper was to study the environmental factors affecting the racing time of Quarter Horses which participated in races held in Sorocaba and Ribeirao Preto racetracks, Sao Paulo state, Brazil. The data consisted of 4684 performances evaluated based on the 1428 animals final time (630 females and 798 males) that have run from 1983 to 1997. The analytical methods involved the GLM procedure of the Statistical Analysis System, SAS (1996). Age of animals (2,3,4 e >4 Years), jockey's weight (44-62 Kg), race year (1983-1997), sex (male, female), origin (national, imported), racetracks (Sorocaba and Ribeirao Preto) and distance (301,320, 365,402 and 503 meters) were the fixed effects considered in the linear model. Racetrack and origin have presented no significant effects (p>0,05). Animal age equal or over 4 years old and

jockey's weight at 59 Kg were the fastest (p<0,001), while those at 2 years old and jockeys at 62 Kg have shown the worst performances. Males and females had no significant difference (p>0,05). The linear regression of the time on the race year has pointed out an animal decrease annual next to 0,16 second, about 2 seconds in the studied period. The decrease occurred, may be, in part, due to improvements in veterinary, nutritional and training features as well as gains obtained by selection. The quadratic regression of the time on distance ($y = -0,077 + 0,0617X - 11E-6X^2$) has shown that when the 402 and 301 distances (101 meters difference) have been compared, a 0,31 m/s increase in the animal speed has occurred (17,51 m/s and 17,2 m/s respectively). In the same way when 503 and 402 distances have been compared (also 101 m difference), a lightly higher increase in the 0,34 m/s speed has been observed.

Key Words: Quarter Horse, race, time

ASAS/ADSA Forages and Pastures: Grazing and Alternative Forages

1893 Growth performance of stocker calves backgrounded on sod-seeded winter annuals or hay and grain. K. P. Coffey*¹, W. K. Coblenz¹, T. G. Montgomery², J. D. Shockey², K. J. Bryant², P. B. Francis², and C. F. Rosenkrans, Jr.¹, ¹University of Arkansas, Fayetteville, AR, USA, ²Univ. of Ar. SE Research and Extension Center, Monticello, AR, USA.

Winter annual forages have the potential to provide a lower-cost, rapid-gain option for retaining ownership of fall-weaned calves. A study was conducted during the winters of 1998, 1999, and 2000 using 180 crossbred calves (261 kg BW) to compare winter backgrounding programs in southeastern Arkansas. Calves were fed bermudagrass hay (ad libitum) and a grain sorghum-based supplement (1% of BW) in drylot (HS) or were grazed on pastures of bermudagrass/dallisgrass overseeded with 1) annual ryegrass (RG), 2) wheat and RG (WRG), or 3) rye and RG (RRG). Calves grazed from mid-December until mid-April, but were fed hay during times of low available forage. During the first two years, calves fed HS gained less (P < 0.05) BW (73.2 kg) than calves that grazed winter annual forages (113.9 kg); gains did not differ (P > 0.10) among RG, RRG, and WRG (121.4, 111.3, and 109.0 kg, respectively). During the third year, undesirable environmental conditions limited growth of the winter annual forages; total gain did not differ (P > 0.10) among the four treatments (65.7, 58.3, 57.0, and 55.0 kg for HS, RG, RRG, and WRG, respectively). Mean CP and IVDMD concentrations were 19.0 and 71.1%, respectively across sampling dates and winter annual forages, but three-way interactions among forage treatments, year, and sampling date were detected (P < 0.01) for available forage, and concentrations of CP, NDF, and IVDMD. Available forage did not differ (P > 0.10) among RG, RRG, or WRG on any sampling date. The IVDMD of RRG was greater (P < 0.05) than that of RG in the 1999. A treatment by sampling date interaction was detected for forage CP in 1998 (P < 0.05) and 1999 (P = 0.05) but not in 2000 (P > 0.10). Winter annual forages offer potential to provide high quality forage for calves retained until spring, but consistent forage production is a concern when sod-seeding techniques are used.

Key Words: Stocker cattle, Winter annuals, Forage quality

1894 Steer grazing behavior on endophyte-free, toxic endophyte-infected, and non-toxic endophyte-infected (Max QTM) tall fescue. J. A. Bondurant*, M. A. McCann, J. S. McCann, J. H. Bouton, C. S. Hoveland, R. H. Watson, and J. G. Andrae, *The University of Georgia, Athens, GA.*

Fescue toxicosis decreases grazing time and depresses performance in cattle as they alter grazing behavior to cope with the toxicosis. In an attempt to capitalize on improved animal performance and health as well as agronomic benefits, non-toxic endophytes that enhance plant persistence have been inserted into tall fescue. The objectives of the present study were to assess grazing behavior in stocker steers grazing non-toxic endophyte-infected (MaxQTM) Jesup tall fescue versus endophyte-free (EF) and toxic endophyte-infected (EI) Jesup tall fescue. Hereford steers weighing approximately 270 kg were stocked at 3.71 hd/ha on replicated (n=2) .809-ha tall fescue paddocks at the Central GA Branch Station for 69 days commencing October 11, 2000. Computerized grazing behavior recorders and jaw movement sensors were fitted to 12 steers for two 5-d collection periods from October 11-16

and December 4-9. Jaw movement data was collected for a minimum of 20 h/hd/d and was analyzed with GRAZETM software. Mean available forage was approximately 3100 kg DM/ha. Steers on all treatments spent less (P<.05) time grazing, a similar (P>.05) amount of time ruminating, and more (P<.05) time in other activities in October. Numbers of grass boli swallowed/h were not different (P>.05) among treatments or periods. Fewer (P<.05) mastications/h and fewer (P<.05) prehensions/h were observed during October versus December. In addition to the period differences, treatments affected grazing behavior. On the toxic EI paddocks, steers had more (P<.05) mastications/h than the cattle on the EF and MaxQTM treatments during October. In December the number of prehensions/h were lower (P≤.05) on the toxic EI paddocks. Time spent neither grazing nor ruminating was lower for cattle on MaxQTM paddocks in December than for cattle on toxic EI or EF treatments. Data from two cool-season periods demonstrates no adverse effects of MaxQTM tall fescue on steer grazing behavior.

Key Words: grazing behavior, tall fescue, MaxQTM

1895 Use of *Ascophyllum nodosum* for alleviation of fescue toxicosis in cattle. J.E. Williams*¹, A. Rodriquez², E. Navarro¹, and D.P. Colling³, ¹University of Missouri, Columbia, MO, ²University of Puerto Rico, Mayaguez, PR, ³Land O'Lakes Farmland Feed, Kansas City, MO.

Cattle grazing endophyte-infected tall fescue (EIF) sprayed with seaweed extract *Ascophyllum nodosum* show reduced fescue toxicosis and improved immune function as compared to untreated animals. In order to evaluate the impact of Tascotm seaweed extract (SWE) and Tascotm seaweed meal (SWM) on fescue toxicosis, a feedlot study was conducted with measures of ADG, DM intake, rectal temperature, and respiration rate. Eighty continental crossbred yearling steers (avg. 291 kg) were assigned to one of four treatments (5 pens per treatment and 4 steers per pen): 1) endophyte-free tall fescue (EFF) seed; 2) EIF seed; 3) EIF seed + 2.0 % SWM; 4) EIF seed + 0.5 % SWE. The EIF seed provided 10 ug ergovaline / kg BW. The EFF seed, EIF seed, and EIF seed with SWE or SWM were fed daily prior to the morning feeding. The SWE and SWM were fed from 0 to 14 d, while the EFF seed and EIF seed were fed from 0 to 42 d. The diet consisted of cottonseed hulls and cracked corn based diet to provide 0.92 Mcal/ kg Neg and 11.2 % CP. Rectal temperatures were recorded 7 times while respiration rates were recorded 13 times throughout the 42 d study. The air temperature (Ta) and % relative humidity (RH) were recorded continuously. During 0 to 14 d, the average Ta was 27.1 C and RH was 71%; for d 14 to 42, the Ta was 27.5 C and RH was 66.7%. During the first 14 d and 14 to 42 d period, respiration rates were not affected (P > 0.30) by treatment. During the first 14 d period, there was a treatment X time (P = 0.10) interaction for respiration rates. Rectal temperature was not affected (P > 0.50) by treatment for either period. ADG, DM intake, and feed / gain ratio were not affected (P > 0.40) by treatment. The moderate Ta conditions were responsible for the lack of an effect of SWE and SWM on reducing respiration rates and rectal temperatures in cattle. Additional studies are warranted to determine the effects of SWE and SWM on reducing signs of fescue toxicosis in cattle.

Key Words: Heat stress, Cattle, Seaweed

1896 The effects of grazing a brown midrib vs a conventional sorghum x sudan hybrid on animal performance and gain/ha. J. B. Banta*, F. T. McCollum, III, and L. W. Greene, *Texas A & M University System, Amarillo.*

Abstract: An experiment was conducted to determine animal performance and gain/ha of beef steers (mean initial wt.: 241 kg) grazing a conventional sorghum x sudan hybrid (C) versus its near isogenic brown midrib (BMR) variety. The experiment was conducted during the summers of 1999 and 2000 in the Texas Panhandle. During both summers 8 pasture plots (2.2 ha) were blocked by location and randomly assigned either C or BMR. Fertilization and irrigation were similar for both varieties. Data were analyzed using a model containing year, block, forage type, and year by forage type. The interactions were not significant. Pastures were grazed using put and take stocking for an average of 41 and 58.5 d at an average stocking rate of 6.71 and 5.10 head/ha for years 1999 and 2000, respectively. Head d/ha, gain/ha, and ADG were determined. Steers grazing BMR tended ($P = .0651$) to gain more rapidly (1.33 kg/d) than steers grazing the C hybrid (1.19 kg/d). Gain/ha (361.5 kg, $P = .12$) and head d/ha (286.9, $P = .98$) were not different. BMR varieties are known for less lignin content, which should result in improved digestibility and thus increased ADG.

Key Words: Beef Cattle, Forage, Digestibility

1897 Use of temperature data loggers to measure body temperature in cows grazing toxic or non-toxic tall fescue. R.H. Watson*, M.A. McCann, J.A. Bondurant, J.G. Andrae, and L.L. Hawkins, *The University of Georgia, Athens, GA.*

Cattle grazing toxic tall fescue often suffer from thermoregulatory dysfunction. Elevated body temperature (BT) is often used as an indication of fescue toxicosis. To better understand the affect of grazing toxic tall fescue on BT, it is necessary to take multiple diurnal measurements while the animal is grazing, which is not possible using hand-held thermometers. Cattle ($n=10$) were randomly selected from herds grazing either toxic or non-toxic tall fescue. Equipment consisted of a temperature data logger (TDL) with 61-cm thermistor cable, housed in a plastic case. A halter was placed on the animal with the TDL attached to the neck strap so that the subcase sat comfortably behind the poll. The thermocouple end of the thermistor was coated with anti-biotic ointment and inserted into the ear canal until it met resistance at a 45° turn near the tympanic membrane. A foam block was molded into the outer ear to hold the cable in place, and insulate the ear canal from the external environment. The ear was wrapped in vet-wrap and elastic tape to secure the foam block. The TDL was programmed to record BT every 15 minutes. After 14 grazing days, the TDL was removed and the data downloaded onto computer. Rectal temperature was recorded at 1200h on the last day of grazing by hand-held thermometer. BT was significantly different between cattle grazing toxic and non-toxic fescue only when environmental temperatures were high ($>23^{\circ}\text{C}$) or low ($<12^{\circ}\text{C}$). There was no significant difference in rectal temperature between toxic and non-toxic cattle (39.4°C and 39.2°C respectively). TDL results showed that BT in cattle grazing toxic fescue is influenced by environmental temperature. The TDL method allowed measurement of BT in grazing animals across a range of environmental conditions, and sampling times.

recorded	Environmental Temp. recorded ($^{\circ}\text{C}$)	Body Temp. ($^{\circ}\text{C}$)	
		Toxic	Non-toxic
0600	9.9	38.2 ^a	38.7 ^b
1200	23.4	38.7	38.9
1800	25.5	40.2 ^a	39.6 ^b
2400	14.7	39.1	38.9

^{a,b}Mean body temperatures in a row are different ($P < .05$)

Key Words: Temperature data logger, Toxic tall fescue, Grazing cattle

1898 Effects on forage quality and animal performance of steers grazing smooth brome pastures interseeded with legumes. M. D. Ullerich*, B. E. Anderson, T. J. Klopfenstein, and M. A. Trammell, *University of Nebraska-Lincoln.*

A trial was conducted to evaluate the effects of interseeding legumes into smooth brome (*Bromus inermis*) pastures on animal performance and forage quality compared to a smooth brome control. Forty-eight

steers (254 ± 16 kg BW) were assigned randomly to one of four treatments consisting of smooth brome pastures interseeded with 1) alfalfa (ALF; *Medicago sativa*), 2) birdsfoot trefoil (BFT; *Lotus corniculatus*), 3) kura clover (KC; *Trifolium ambiguum*), or 4) fertilized with 56 kg N/ha (CON). Steers rotationally grazed during four 36-day periods (May 2 to September 22). In addition, four ruminally fistulated steers were assigned to one of the four treatments in a 4 x 4 Latin square design. Diet and omasal samples were collected. Forage diet samples contained (DM basis) 62.1% in vitro digestible dry matter (IVDMD), 16.80% CP, and 1.48% undegradable intake protein (UIP; % DM) for ALF; 62.9% IVDMD, 16.30% CP, and 1.45% UIP for BFT; 70.8% IVDMD, 17.40% CP, and 1.46% UIP for KC; and 62.6% IVDMD, 16.10% CP, and 1.39% UIP for CON. The UIP contents of the diets across treatments were not statistically different. Undegradable intake protein content of omasal samples were similar to diet samples. Animal gains on legume/brome treatments were higher ($P < .05$) than the control (0.89 kg/d vs. 0.78 kg/d) with KC gaining the most (0.93 kg/d). The IVDMD were higher ($P < .10$) for the legume/brome treatments than the control with KC being the most digestible. Therefore, the increases in gain may be attributed to the increased energy of the legume/grass diets and not a protein (UIP) response when compared to a smooth brome control.

Key Words: Undegradable Intake Protein, Grazing Cattle, Legumes

1899 Tall fescue based forage systems for developing beef replacement heifers. J.C. Waller*¹, F.N. Schrick¹, M.C. Dixon³, A.E. Fisher¹, A.M. Saxton¹, and H.A. Fribourg², ¹Department of Animal Science, University of Tennessee, ²Department of Plant and Soil Sciences, University of Tennessee, ³Ames Plantation, Grand Junction, TN.

Effects of *Neotyphodium coenophialum* infested (E+) tall fescue (*Festuca arundinacea*) based forage systems on heifer growth and reproductive competence were evaluated. Each year, 36 fall-born heifers were weaned in mid-June and randomly allotted to one of four triplicate pasture treatments: (1) E+ tall fescue; (2) E+ tall fescue with ladino white (*Trifolium repens*) and red clover (*T. pratense*); (3) endophyte free (E-) tall fescue; (4) E- tall fescue with clovers. Each 1.2 ha pasture was stocked with 3 heifers. Weaned heifers grazed from mid-June to mid-November. All heifers were removed from experimental pastures, estrus was synchronized, bred artificially, and exposed to a bull. At 30 and 60 d after insemination, pregnancy was diagnosed by ultrasonography. Bred heifers were re-allotted to the same pasture treatment grazed as weaned heifers. Grazing occurred from early March until the end of calving season in December. A mixed model (SAS) blocked on year (1995-2000) was used to test fescue, clover, calf sex, and weaned/bred fixed effects. Quadratic regression for repeated measures over weigh dates was used to estimate average daily gain (ADG). Heifers (weaned and bred) grazing E- tall fescue had higher ($P < 0.05$) ADG than heifers grazing E+ tall fescue, 0.59 and 0.46 kg d⁻¹ respectively. The presence of clover improved ($P = 0.05$) performance of heifers grazing E+ and E- tall fescue. Once confirmed pregnant, no differences in fetal losses of heifers grazing either E+ or E- tall fescue were observed. Calf birth weight was lower ($P < 0.05$) when dams grazed E+ tall fescue than when dams grazed E- tall fescue, 24.5 and 31.7 kg, respectively. Bull calves weighed more ($P < 0.05$) than heifer calves at birth on E+ and E- tall fescue systems. The difference in calf birth weight may be explained by decreased ADG of bred heifers grazing E+ tall fescue.

Key Words: tall fescue, replacement heifers, *Neotyphodium*

1900 Effect of grain supplementation on methane production of grazing steers. D. A. Boadi*¹, K. M. Wittenberg¹, and W. P. McCaughey², ¹University of Manitoba, Winnipeg, Manitoba Canada, ²Agriculture and Agri-Food Canada, Brandon, Manitoba Canada.

The objective of the study was to examine the effects of supplemental grain on methane (CH₄) production of grazing steers. Eight beef steers (344.6 ± 6.4 kg) were assigned to legume- grass pastures (CON; $n = 4$) or legume-grass pastures and a rolled barley supplement (SUP; $n = 4$). In a completely randomized design with repeated measures, CH₄ production was measured for 2-24 hr periods using the SF₆ tracer gas technique as steers entered and exited paddocks. Two, 4 and 4 kg of rolled barley was fed to SUP steers during the Early (June 17-25 1998), Mid (July 20-29 1998) and Late (Aug. 12-21 1998) period of the grazing season, respectively. Supplementation reduced forage DMI by 11%

($P = 0.03$), and increased total digestible OMI (TDOMI) by 20% ($P = 0.001$) of SUP steers. Daily CH_4 production was similar for CON (310.5 25.9 Ld^{-1}) and SUP (331.2 24.6 Ld^{-1}) steers ($P = 0.58$). Methane, % of total gross energy intake (TGEI) ranged from 4.7 to 8.4% (mean 6.5 0.3%) during the grazing season, and there was no difference between SUP (6.4 0.6%) and CON (6.7 0.6%) steers ($P = 0.71$). There was a diet x period interaction in the grazing season ($P < 0.05$), where (LCH_4 , $\text{kg}^{-1}\text{TDOMI}$) was lowered by 29% with grain supplementation only during the Mid period ($P < 0.05$). The lower (CH_4) loss observed during the Mid period was however 38% lower ($P < 0.05$) than losses occurring during the Early period without supplementation. It can be concluded that there were marginal effects of supplementation on CH_4 production and the study implies that pasture quality plays a major role on the extent to which CH_4 production can be lowered with grain supplementation in grazing animals.

Key Words: Methane production, Grazing steers, Grain supplementation

1901 Effect of infusing protein post-rotationally and graded levels of ruminally available protein on the utilization of low-quality prairie hay by beef steers. T. A. Wickersham*, R. C. Cochran, E. C. Titgemeyer, C. G. Farmer, E. A. Klevesahl, and J. I. Arroquo, *Kansas State University, Manhattan.*

An experiment was conducted to evaluate the effect of infusing post-ruminal protein (P) with graded levels of supplemental ruminally available protein (R) on low-quality prairie hay utilization. Twelve ruminally fistulated steers (BW = 361 kg) were used in a 12-treatment, 2-period, crossover design. Steers were subjected to a 17-d depletion period (ad libitum access to hay only) before onset of the trial. Each period had 5 intervals: 1) 10-d adaptation to treatments; 2) 7-d measurement of intake and digestibility; 3) 3-d ruminal sampling; 4) 10-d ad libitum access to hay only; 5) 7-d measurement of intake. Steers were given ad libitum access to prairie hay and supplemented in a 2×6 factorial arrangement of treatments. For the first factor, steers were abomasally infused once daily with one of two levels of sodium caseinate (0 and 0.087% of initial BW; P) via anchored infusion lines into the abomasum. For the second factor, steers were ruminally dosed once daily with one of six levels of sodium caseinate powder (0, 0.029, 0.058, 0.087, 0.116, and 0.145% of initial BW; R). Provision of R linearly increased total OM intake, total digestible OM intake (TDOMI), and OM digestibility ($P \leq 0.03$). Infusion of P increased hay OM intake ($P = 0.06$). Additionally, P increased total OM intake, TDOMI, and OM digestibility ($P \leq 0.01$). In the absence of supplemental R, P-supplemented steers consumed 50% more TDOMI than those receiving no P. However, as R supplementation increased the additional benefit from P decreased. Addition of P at 0.087% of BW with no R increased TDOMI 65% as much as R at the same level. In conclusion, both R and P improved forage utilization; however, the response to direct ruminal protein provision was greater. Improvements in forage utilization in response to P are likely dependent on N recycling.

Key Words: Beef Cattle, Forage, Protein

1902 Soybean genotypes for grain and stover in smallholder crop-livestock systems in West Africa. Asamoah Larbi*¹, Baffour Asafo-Adjei², Olayinka Yusuf³, and Adekunle Isiaka⁴, ^{1,3}*International Livestock Research Institute (ILRI), West Africa, Ibadan, Nigeria*, ²*International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria*, ⁴*Federal University of Agriculture, Abeokuta, Nigeria.*

Soybean (*Glycine max* (L) Merrill) stover has potential as feed for ruminants, but information on feed value of the stover is limited in sub-Saharan Africa where production is expanding, crop residues are important dry season livestock feed, and source of income. The extent of variation in grain and stover yields and stover quality among 19 early-, 20 medium- and 20 late-maturing soybean genotypes was determined, and genotypes with potential for higher grain and quality stover yields were identified. Stover and grain yields, and stover quality (crude protein, neutral detergent fibre and 48-hour dry matter disappearance) varied ($P < 0.01$) among genotypes for all maturity types. Grain and stover yields were positively correlated (early: $r = 0.79$, medium, $r = 0.85$; late, $r = 0.78$). Genotypes (early: TGX 1878-30E, TGX 1880-3E; medium: TGX 1873-6E, TGX1869-14E; late TGX 1869-13E, TGX 1440E) with potential for higher yields of both grain and stover, and better stover

quality were identified based on the agronomic and stover quality attributes. The results suggest that stover and grain yield characteristics can be combined in breeding programs to select dual-purpose genotypes for smallholder crop-livestock systems in the northern Guinea savanna zone of west and central Africa.

Key Words: Soybean, Stover and Grain, Stover quality

1903 Yield and fodder quality of dual-purpose groundnut genotypes fed to West African Dwarf sheep. I. Etela¹, A. Larbi*², P.E. Olorunju³, D.D. Dung⁴, and U.I. Oji⁵, ¹*Department of Animal Science, University of Benin, Benin City, Nigeria*, ²*International Livestock Research Institute (ILRI), Ibadan, Nigeria*, ³*Institute of Agricultural Research, Samaru, Nigeria*, ⁴*National Animal Production Research Institute, Shika, Nigeria*, ⁵*Department of Animal Science, University of Science and Technology, Port Harcourt, Nigeria.*

Smallholder farmers in the subhumid zone of West and Central Africa grow groundnut (*Arachis hypogaea* L.) for both seed for humans and fodder for livestock. Genotypes with potential for higher grain and quality fodder yields (dual-purpose genotypes) have recently been selected for smallholder crop-livestock systems in the region, but data on the fodder quality of the dual-purpose genotypes in terms of animal output is scanty. The objective of this study was to compare fodder and seed yields and fodder quality of six dual-purpose genotypes (M170-80I; M554-76; M572-80I; RMP-12; UGA-2; UGA-5). Fodder and seed yields were determined over a 2-year period. Sun-dried fodder of the genotypes was fed as a sole diet to West African Dwarf sheep using a randomized block design with six animals per genotype to determine nutrient intake and digestibility, nitrogen balance, and daily weight changes. Genotype had significant ($P < 0.05$) effect on fodder and seed yields, fodder crude protein (85 - 89 g/kg), neutral detergent fiber (519 - 586 g/kg), lignin (105 - 148 g/kg) concentrations, dry matter (DM) intake (range: 65 - 80 g/kg BW), DM digestibility (33 - 50 g/kg), nitrogen retention (1.2 - 4.3 g/day), and liveweight changes (range: - 6 - 46 g/day). Genotypes M170-80I and UGA-5 had greater potential for higher yields of seed and quality fodder.

Key Words: Fodder, seed, Chemical composition, Liveweight

1904 Grazing method effects on growth rate of St. Croix White hair sheep lambs on a tropical grass-shrub legume over-story. E. Valencia* and R.W. Godfrey, *University of the Virgin Islands, Agricultural Experiment Station, St. Croix VI USA.*

In the seasonally dry eastern Caribbean islands, growing small ruminants are sensitive to availability of high quality tropical grasses. The potential for improved weight gains by growing hair sheep and dry season yield of guineagrass (*Panicum maximum* Jacq.)-Leucaena (*Leucaena leucocephala* Lam de. Wit) was investigated. St Croix White hair lambs (4 mo. of age) were utilized to compare two different grazing systems, with three replicates within each treatment. In the continuous grazing system (CS) each replicate of lambs ($n = 5$) grazed guineagrass-leucaena (10-15% over-story) pastures (.14 ha) at a stocking rate of 650 kg BW/ha/d for a period of 98 d. In the rotational grazing system (RS) each replicate of lambs ($n = 5$) grazed guineagrass-leucaena (10-15% over-story) pastures (.14 ha) at 650 kg BW/ha/d for 126 d. In the RS, each .14 ha pasture was subdivided into 3 equal paddocks and lambs were moved every 14 d which allowed each paddock a 28-d rest period. Lambs were weighed weekly throughout the trial. Forage dry matter yield was estimated in five .25m² areas in each paddock. Pastures were sampled every 28 d in CS and every 14 d in RS. All data were analyzed using GLM procedures of SAS. There was a trend ($P = .09$) for higher average daily gain for sheep on CS (68 ± 3.7 g/d) compared to those on RS (46 ± 3.7 g/d). However, seasonal forage yield was favored ($P < .05$) by RS ($3.5 \pm .4$ Mg/ha) compared to CS ($1.8 \pm .4$ Mg/ha). At season-end, sheep on CS had to be supplemented with leucaena on a cut-carry system (1.6 kg DM/d) as regrowth of leucaena was affected. Grazing selectivity increased under CS, but also favored encroachment of the low-quality hurricane grass (*Bothriocloa pertusa*). These results suggest that weight gains are slightly better under CS, but will require supplementation during the dry season. Forage yield during the dry season is better under RS and may favor the grass-legume over-story in the long-term.

Key Words: Tropical Grasses, Hair Sheep, Weight Gain

ASAS/ADSA Physiology: Reproductive Physiology

1905 Use of ECP in a timed insemination program.

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Experiment 1 evaluated pregnancy rates (PRs) when estradiol cypionate (ECP) replaced the second GnRH injection of a timed artificial insemination (TAI) protocol for lactating dairy cows. Cows were pre-synchronized with two injections of PGF_{2α} (Lutalyse[®], Pharmacia Corp., 25 mg; i.m.) given to multiparous cows (n=170) at 40 ± 3 and 54 ± 3 d postpartum (dpp) and to primiparous cows (n=201) at 62 ± 3 and 76 ± 3 dpp. The TAI protocol consisted of an injection of GnRH (Cystorelin[®]; Merial Ltd., 100 µg, i.m.) at 68 ± 3 and 90 ± 3 dpp for multiparous and primiparous cows, respectively, followed by PGF_{2α} 7 d later. Cows were injected with GnRH (Treatment I: Ovsynch, n=179) 48 h after PGF_{2α} and inseminated 16 h later. In Treatment 2 (ECP-synch; n=192), ECP[®] (Pharmacia Corp., 1 mg, i.m.) was injected 24 h after PGF_{2α}, and cows were inseminated 48 h later. Pregnancy was determined at 46 ± 3 d after TAI. For primiparous and multiparous cows, PRs for Ovsynch were 43.5 ± 6.9 and 30.6 ± 7.2 % compared to 50.7 ± 6.3 and 19.4 ± 6.5 % for ECP-synch. Effects of parity (P<0.01) and parity by treatment (P<0.10) were detected on PRs. In Experiment 2, onset of estrus and time of ovulation were determined in lactating dairy cows submitted to the ECP-synch protocol as described in Experiment 1. Estrus was detected by HeatWatch[®] and ovulation time determined by ultrasound at 8-h intervals beginning 18 h after onset of estrus or at 48 h after ECP injection. Frequencies of detected estrus and ovulation were 75.7 % (28/37) and 89.2 % (33/37), respectively. Mean intervals to ovulation were 58.5 ± 4.0 h (n=33) after ECP and 27.1 ± 1.1 h (n=28) after onset of estrus. Estrus occurred at 33.6 ± 4.4 h (n=27) after ECP. Percent cows ovulating at an optimal interval of ≥42 h to ≤70 h after ECP was 75.8 % (n=25/33). Synchronization of ovulation and fertility results indicated that ECP can be utilized to induce ovulation for a timed insemination.

Key Words: Timed artificial insemination, ECP, Ovulation

1906 Determining the effect of gonadotropin releasing hormone to synchronize returns to estrus in dairy heifer.

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This study evaluated the efficacy of gonadotropin releasing hormone (GnRH) administered on day 21 post breeding to synchronize returns to estrus. One hundred-twenty-two Holstein heifers were initially synchronized using 2 injections of prostaglandin F_{2α} (PG). Twenty-five mg PG were administered im on days 0 and 11. HeatWatch[®] transmitters were applied on day 11 and monitored estrus activity for the remainder of the trial. The heifers were bred by fixed-timed artificial insemination on day 14 and randomized into two groups (treatment and control). On day 35, the treatment group received 100 µg GnRH im and the control group received 2 ml saline im. Pregnancy status was determined on day 42 using transrectal ultrasonography. Heifers that were not pregnant (n=85) were given a 25 mg injection of PG im and estrus activity was monitored until day 48. There was no difference in median time to estrus between treatment groups. Data on heifers that returned to estrus (n=56) were analyzed using a Fischer's exact test. Data cells were collapsed into groups that expressed estrus at <60 hrs post PG and >60 hrs post PG. The GnRH group had significantly greater synchrony (p<0.05) than the saline group. More heifers in the GnRH group expressed estrus in the first 60 hrs following PG administration as compared to the saline group. Eighty five percent of the GnRH group expressed estrus between 36-60 hrs after PG administration compared to 55% of the saline group. In this study, GnRH was not efficacious in synchronizing returns to estrus when administered 21 days post breeding because of the large number of heifers that did not return to estrus. However, heifers that did return to estrus had greater synchrony if treated with GnRH compared to saline.

Variable	GnRH	Saline
n	41	44
Observed in estrus	27	29
Median time to estrus (hrs)	45	57
<36 hrs	1 (4%)	2 (7%)
36-60 hrs	23 (85%)	16 (55%)
>60 hrs	3 (11%)	11 (38%)

Key Words: Heifer, Synchronization, GnRH

1907 Efficacy of using Ovsynch to initiate artificial insemination at the onset of the breeding season in lactating dairy cows managed for seasonal calving in a grazing based dairy system.

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Lactating dairy cows (n=226) were subjected to a 21 d artificial insemination (AI) breeding period beginning at the onset of the breeding season (Day 0) followed by introduction of natural service sires. Throughout the AI breeding period, cows received AI based on tail paint removal, which was evaluated twice daily at milking. Beginning 10 d before the breeding season, cows were randomly assigned to receive synchronization of ovulation (50 mg GnRH, Day -10; 25 mg PGF_{2α}, Day -3; 50 mg GnRH, Day -1) and fixed-time AI (Day 0) followed by estrus detection and AI for the remainder of the AI breeding period (Ovsynch; n=114), or estrus detection and AI for the duration of the AI breeding period (Control; n=112). Blood samples collected on Day -20, -10, -3, and -1 were classified based on serum progesterone (P) concentrations as High (≥0.5 ng/ml) or Low (<0.5 ng/ml). Overall, the proportion of anestrus cows (Low P on Day -20 and -10) was 14% (31/220) and did not differ between treatment groups. Although days to first AI was greater (P<0.01) for Control vs. Ovsynch cows (12.0 vs. 0.0, respectively) and the 21-d AI service rate was greater for Ovsynch vs. Control cows (100%, 114/114 vs. 86%, 96/112, respectively), conception rate to first AI service was greater (P<0.01) for Control vs. Ovsynch cows (47%, 43/91 vs. 27%, 30/100, respectively). Only 61% (69/114) of Ovsynch cows underwent luteolysis (50% reduction in P from Day -3 to Day -1) after PGF_{2α} administration. No Control cows received a second AI service during the AI breeding period, compared to 47% (51/108) of Ovsynch cows (mean d to second AI = 17.58). Conception rate to second AI service was 43% (22/51), which did not differ from that of Control cows at first AI service. Cumulative pregnancy rate for Control and Ovsynch cows was similar at Day 49 (47%, 43/91 vs. 46%, 50/108, respectively) and Day 179 (80%, 66/82 vs. 83%, 80/96, respectively). Ovsynch failed to synchronize lactating dairy cows managed in a grazing based dairy system thereby resulting in lower first service conception rates than AI to spontaneous estrus. Tail paint is an effective reproductive management tool for conducting AI in grazing based dairies. Supported by Hatch project WIS04222

Key Words: Ovsynch, TAI, Grazing

1908 Ovulation synchronization protocols affect early postpartum reproductive efficiency in crossbred dairy cows.

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Crossbred Holstein-Gir cows have lactation curves with low persistence and high incidence of postpartum anestrus, which negatively impact profitability. Objectives of this study were to evaluate three ovulation synchronization protocols and their impacts on reproductive efficiency. The study was conducted between March and December of 2000 in Brazil. Cows were randomly assigned to one of the four treatments: 1) Control (n=118), which consisted of estrus detection and prostaglandin injections in cows with a palpable corpus luteum (CL) every 14 d; 2) GnRH (Cystorelin[®], 50mcg, im)-6d-PGF_{2α} (Lutalyse[®], 25mg, im)-2d-GnRH-16 to 18h-AI (n=133); 3) GnRH-5d-GnRH-6d-PGF_{2α}-2d-GnRH-16 to 18h-AI (n=132); and 4) CIDR + GnRH-6d-PGF_{2α} + CIDR removal-2d-GnRH-16 to 18h-AI (n=129). PGF_{2α} injection on day 6 after the first GnRH aimed to optimize ovulation synchronization after the last GnRH injection. Treatment with two GnRH injections 5d apart intended to increase the proportion of cows with a responsive CL when PGF_{2α} was used. Use of CIDR in conjunction with GnRH aimed to minimize the incidence of short luteal phases in cows that might not

respond to the first GnRH. Interval from the end of the VWP to conception and days open were analyzed by ANOVA. Interval from the end of the VWP and conception were affected by treatment ($P < 0.01$) and averaged 49.1 ± 5.5 , 34.8 ± 4.8 , 31.9 ± 5.1 , and 28.1 ± 5.1 days for treatments 1, 2, 3, and 4, respectively. Similarly, days open were affected by treatment ($P < 0.01$) and averaged 127.7 ± 5.5 , 114.0 ± 4.8 , 110.6 ± 5.1 , and 107.1 ± 5.1 days, respectively. An interaction between parity and treatment was detected ($P < 0.05$) for the interval between the end of the VWP and conception. This interval was reduced in primiparous cows receiving treatments 2, 3, and 4 compared with those on treatment 1, indicating that ovulation synchronization protocols might induce cyclicity. Reproductive protocols that synchronize ovulation reduced the interval from the end of the VWP to conception and days open when compared with regular prostaglandin treatments.

Key Words: lactating dairy cows, synchronization, anestrous

1909 Administration of hCG during estrus and its effect on corpus luteum size and progesterone production. J.A. Bartolome, S.M. Pancarci*, T. Dickerson, L.F. Archbald, and W.W. Thatcher, *University of Florida, Gainesville, FL.*

Progesterone (P4) production by the corpus luteum (CL) influences establishment and maintenance of pregnancy in cattle. Human Chorionic Gonadotropin (hCG) has LH-like activity, binds LH-receptors in luteal tissue and stimulates luteinization. The objective of this study was to evaluate the ability of hCG to enhance CL development and increase production of P4 when injected at estrus to supplement the natural LH surge. Twenty-three cows were treated with GnRH (100 ug, im, Cystorelin®) and PGF_{2α} (25 mg, im, 2 doses 8 hs apart, Lutalyse®), 7 d later. Seventeen cows that showed estrus (according to Heat Watch®) between 2 and 3 d after PGF_{2α} were randomly assigned to receive either hCG (3,000 IU, im, Chorulon®, n=9) or saline (n=8) 8 to 10 h after the onset of heat. Blood samples were collected every 12 h and ovarian ultrasound examination was done every three days to evaluate plasma P4 concentration, number of follicular waves and CL size during 23 days after treatment. Data for plasma P4 concentration and CL size were evaluated using repeated measures ANOVA for mixed models, and the number of follicular waves were compared using Fisher exact test. There was no difference in the number of follicular waves between cows treated with hCG (78% of cows with 2 waves) and control cows (75% of cows with 2 waves). Plasma P4 concentration was lower in cows treated with hCG (6.46 ng/ml) than in control cows (7.89 ng/ml; $P < 0.05$), with major differences detected between days 14 and 16. In addition, on day 16, CL tended to be smaller ($P < 0.08$) in cows treated with hCG compared to control cows. It was concluded that the administration of hCG during the spontaneous LH surge may have produced an excess of LH and LH-like activity and negatively affected CL differentiation and development.

Key Words: hCG, corpus luteum, progesterone

1910 Follicular dynamics in postpartum cows after treatment with either GnRH or Estradiol benzoate (EB) at the initiation of a 7 d controlled intravaginal progesterone-releasing device (CIDR). MK. V. Dahms*, C. R. Barthle, E. A. Hiers, G. E. Portillo, and J. V. Yelich, *University of Florida, Gainesville.*

Crossbred (*Bos indicus* X *Bos taurus*) lactating cows averaging 56 d (range 23-77 d) postpartum were used to characterize follicular dynamics after treatment with either EB or GnRH at the initiation of a 7 d CIDR (Eazi-Breed™ CIDR®; day of insertion = d 0). Cows were allotted to treatments by cycling status and size of the largest follicle present on the ovaries on d 0 of experiment as determined by ultrasonography (US). At d 0, treatments 1 (n = 7; USGCIDR) and 3 (n = 8; GCIDR) were administered 100 µg GnRH i.m. (Fertagyl) and treatments 2 (n = 7; USEBCIDR) and 4 (n = 5; EBCIDR) were administered 2 mg EB i.m. On d 7 of the experiment, CIDRs were removed and all cows received 25 mg PGF_{2α} i.m. (Lutalyse). In the USGCIDR and USEBCIDR cows, ovaries were examined via US daily from d 0 until observed estrus, and 7 d after estrus or d 14 of experiment if estrus was not observed. Ovaries were examined in the GCIDR and EBCIDR cows on d 0 and 7 of the experiment, and 7 d after estrus or d 14 of experiment if estrus was not observed. Estrus was detected using Heat Watch®. Response to treatment on d 0 in USGCIDR was defined as ovulation to GnRH (71.4%), and as turnover of the largest follicle to EB (100%) in USEBCIDR cows. Of cows responding to treatment, day of emergence of the next follicular

wave occurred earlier ($P > 0.10$) in USGCIDR (3.3 ± 0.6 d) compared to USEBCIDR (4.1 ± 0.6 d). Diameter of the newly emerged follicle(s) on d 7, 8 and 9 of the experiment were similar ($P > 0.10$) between USGCIDR (10.3, 11.1 and 13.0 mm; respectively) and USEBCIDR (9.9, 11.0 and 11.4 mm; respectively) cows. Estrus expression was influenced by US as fewer ($P < 0.05$) USGCIDR and USEBCIDR (7/14 = 50%) cows exhibited estrus than GCIDR and EBCIDR (12/13 = 93%) cows. Interval to the onset of estrus was similar ($P > 0.05$) within the US and non-US treatments, but the US (65.5 ± 13.1 h) cows had a shorter ($P < 0.05$) interval than non-US (84.7 ± 9.3 h) cows. Diameter of the ovulatory follicle was similar for USGCIDR (15.0 mm) and USEBCIDR (14.7 mm). These results suggest that there is no significant difference in follicular development between the GCIDR and EBCIDR treatments, although daily US significantly affected estrus behavior after CIDR removal.

Key Words: CIDR, Estrogen, GnRH

1911 Resynchronization of Ovulation and Timed Insemination in Beef Cattle. S Lares*¹, G Dominguez¹, N Formia², C Scena³, O Rambeaud⁴, and R.L. de la Sota¹, ¹Instituto de Teriogenologia, Fac. Cs. Veterinarias-UNLP, ²Escuela M.C. y M. Inchausti-UNLP, ³Intervet Argentina SA, ⁴INTA-Brandsen.

A field trial was conducted to evaluate the effectiveness of Resynch, a resynchronization protocol for prompt insemination of cows diagnosed open at d 25 post AI. Postpartum suckled beef cows with BCS >3 (scale 1-5) were randomly allocated to one of four treatments: 1) Norgestomet implant d0-9, 400IU PMSG d9, timed AI (TAI) d11 (n=21; NOR-TAI); 2) same as 1 plus heat detection (HD)+AI d9-10, TAI d11 of remaining cows (n=21; NOR-IDH); 3) 8ug GnRH (Buserelin) d0, 25mg of PG (cloprostenol) d7, 8ug GnRH+TAI d9 (n=19; COS-TAI) and 4) same as 3 plus HD+AI d7-8, 8ug GnRH+TAI d9 (n=20, COS-IDH). Calves did not suckle for 48 h (NOR protocols, d9-11; COS protocols, d7-9). The Resynch protocol was: 8ug GnRH d18, pregnancy diagnosis with ultrasonography d25, and open cows were injected with 25mg of PG on d25 and 8ug GnRH+TAI on d27. Calves did not suckle for 48 h (d25-27). Pregnancy diagnosis was repeated at d25 after the 2nd AI to evaluate the PR to the Resynch protocol and the early embryonic death. The CATMOD procedure in SAS was used to analyze the data. First AI pregnancy rate (PR) were not different between the NOR groups (43 [TAI] vs. 43%[IDH]) and between the COS group [47[TAI] vs. 40% [IDH]]. The PR for cows diagnosed open and resynchronized were not different between the NOR groups (46[TAI] vs. 58%[IDH]) and between the COS groups (20[TAI] vs. 25%[IDH]). Furthermore, the accumulated PR for both AI were also not different between the NOR (67[TAI] vs. 76%[IDH]) and the COS groups (58[TAI] vs. 55%[IDH]). Hence, data were pooled into two groups (cows synchronized with NOR vs. COS) and were reanalyzed. Although PR were not different in the 1st AI (43 vs. 44%), the PR was higher in the NOR group compared to the COS group in the resynchronized cows (52 vs. 23%; $p < 0.05$) and the accumulated PR for both rounds of AI (71 vs. 56%; $p < 0.05$). The early embryonic death rate was 4% (2/46). In conclusion, the Resynch protocol successfully resynchronized open cows for TAI but the PR depended on the type of protocol used for the 1st AI. Cows 1st synchronized with a progestin had a 29% higher PR in the 2nd AI compared to those synchronized with GnRH. Also they had a 15% higher accumulated PR. Supported with grants BID AR/OC 08-04360 and UNLP-V11/107 to RLS.

Key Words: Timed insemination, Resynchronization, Early pregnancy diagnosis

1912 Luteolysis after PGF_{2/alpha} on day 6 or 7 of the estrous cycle in Angus and Angus x Brahman heifers. G. E. Portillo*, E. A. Hiers, C. R. Barthle, MK. V. Dahms, W. W. Thatcher, and J.V. Yelich, *University of Florida, Gainesville, Florida.*

Cycling Angus and crossbred Brahman heifers (5/8 Angus x 3/8 Brahman and 3/8 Angus x 5/8 Brahman) were used to evaluate the effectiveness of a single injection of PGF_{2/alpha} administered during the early estrous cycle to initiate corpus luteum (CL) regression (CLREG) as measured by progesterone concentrations. Estrous response (ESTRES), interval from PGF_{2/alpha} to the onset of estrus (INTEST), duration of estrus (ESTDUR), and total number of mounts received (TMTS) during the duration of estrus were also evaluated. Heifers were pre-synchronized with a modified two-injection PGF_{2/alpha} (Lutalyse) protocol (25 mg

i.m. on d 14 and 12.5 mg i.m. on d 3 and 2 of the experiment). Estrus was designated as d 0 of experiment. On d 6 or 7 of the subsequent estrous cycle, heifers were injected with 25 mg $\text{PGF}_{2/\alpha}$ i.m. Estrus was monitored using HeatWatch[®] for the pretreatment synchronization and treatment phase of the experiment. The experiment was replicated twice using the same pre-synchronization and treatment protocols and heifers. There were no replication or replication by breed effects ($P \geq 0.10$) so data were pooled. CLREG was greater ($P \leq 0.05$) for Angus (25/26 = 96.2%) than for crossbred (25/31 = 80.6%) heifers. The ESTRES was similar ($P \geq 0.10$) between Angus (15/26 = 57.7%) and crossbred (21/31 = 67.7%) heifers. INTEST and ESTDUR were similar ($P \geq 0.10$) between Angus (51.5 \pm 3.8; 10.6 \pm 1.4 d, respectively) and crossbred (52.4 \pm 3.1; 12.9 \pm 1.1 d, respectively). Crossbred heifers had more ($P \leq 0.05$) TMTS than Angus (51.1 \pm 7.1 vs. 28.9 \pm 9.2, respectively). In conclusion, breed had a significant effect on the ability of $\text{PGF}_{2/\alpha}$ to regress the early (d 6 or 7) developing CL as more Angus than crossbred heifers had CL regression.

Key Words: *Bos indicus*, $\text{PGF}_{2/\alpha}$, Corpus luteum Regression

1913 Reproductive performance of beef heifers following administration of an oral progestogen or GnRH. H. E. Blackmon*¹, M. E. Hockett¹, T. M. Towns¹, N. R. Rohrbach¹, R. B. Simpson¹, A. M. Saxton¹, and F. N. Schrick¹, ¹Department of Animal Science, University of Tennessee, Knoxville.

Oral progestogen or GnRH was administered to beef heifers 60 days prior to the breeding season to examine effects on reproductive performance. During a 3 year replicated study, 222 beef heifers were allotted by weight (320 \pm 3 kg), age (11 to 13 mo), and breed (Angus, n = 198; Hereford, n = 24) to one of three treatments: 1) 2 mL saline (CON, n = 74), 2) 2 mL GnRH (GnRH, n = 74), and 3) 2 mL saline and 0.75 mg/(hd) melengestrol acetate for 14 days (MGA, n = 74). Control and GnRH heifers were fed non-MGA pellets for 14 days. Blood samples were collected twice 10 d prior to the start of the study (Period 1) and before the breeding season (Period 2) to determine cyclicity (progesterone > 1.0 ng/mL). Estrus was synchronized and heifers inseminated (AI) following visual estrus. Heifers not exhibiting estrus were time-inseminated at 48 h after implant removal. Following AI, heifers were exposed to bulls through the breeding season. Pregnancy was determined at 30 and 150 d following AI. A SAS based mixed model and Chi square were utilized for analysis of data. Fifty-two percent of heifers were prepubertal prior to initial treatments (Period 1), and exhibited an increased cyclicity prior to the breeding season (Period 2) after administration of MGA (59%) compared to CON (26%; $P = 0.02$), with GnRH (37%) intermediate. However, AI pregnancy rates did not differ (MGA, 41; GnRH, 35; and CON, 37%). In heifers cycling prior to the study (48%), AI pregnancy rates were higher in MGA (67%) and GnRH (65%) heifers compared to CON (43%; $P = 0.06$). Overall AI pregnancy rates were increased in MGA (55%) heifers than CON (40%; $P = 0.07$); whereas, GnRH (46%) heifers were intermediate. In conclusion, administration of MGA to prepubertal heifers 60 days prior to breeding increased cyclicity at initiation of the breeding season, but did not improve AI pregnancy rates. Treatment with MGA and GnRH increased pregnancy rates in heifers that had attained puberty prior to study.

Key Words: Progestogen, Puberty, Pregnancy

1914 A comparison of three progestin-GnRH-prostaglandin $\text{F}_{2\alpha}$ (PG) based protocols for estrus synchronization of beef cows. J. E. Stegner*, J. F. Bader, F. N. Kojima, M. F. Smith, and D. J. Patterson, University of Missouri, Columbia, MO.

This experiment was designed to compare three progestin-GnRH-PG based protocols for estrus synchronization in beef cows. Primi- and multiparous cycling crossbred cows were assigned to one of three treatments. Cows assigned to treatment 1 (T1) were fed melengestrol acetate (MGA; .5mg \cdot hd⁻¹ \cdot d⁻¹) for 14 d followed by an injection of GnRH (100 μ g Cystorelin[®]) on d 26 and PG (25 mg Lutalyse[®]) on d 33. Cows assigned to Treatment 2 (T2) were fed MGA for 17 d followed by GnRH on d 19, and PG on d 26. Cows assigned to Treatment 3 (7-11 Synch; T3) received MGA for 7 d followed by PG on d 7 of MGA, GnRH on d 11, and PG on d 18. Transrectal ultrasonography was performed daily on all cows to monitor follicular dynamics during the MGA feeding period and through the synchronized period after PG. Response to GnRH,

determined by ovulation of the dominant follicle at the time GnRH was administered, was as follows: 8/9 (88 %), 6/9 (66 %), and 8/8 (100 %) for cows assigned to T1, T 2, and T3, respectively ($P > .10$). Beginning 48 h after PG, ultrasonography was performed every 12 h until ovulation occurred. Cows were observed for signs of behavioral estrus for 7 d after PG. Estrus response for cows assigned to each treatment was as follows: 9/9 (100 %), 7/9 (77 %), and 8/8 (100 %) for cows assigned to T1, T2, and T3, respectively ($P > .10$). Two of 9 cows (22 %) in T2 exhibited estrus 24 h before PG. Mean interval to estrus was shorter ($P < .01$) for cows assigned to T2 (46 \pm 4.6 h), and T3 (52 \pm 4.2 h), than in cows assigned to T1 (79 \pm 7.8 h). The range in estrus response was 48-126, 24-54, and 24-60 h for cows assigned to T1, T2 and T3, respectively. Synchrony of estrus after PG did not differ among treatments. Follicular diameter at GnRH, PG, or 24-72 h after PG did not differ ($P > .10$) among treatments. Characterization of follicular dynamics and timing of estrus from these data will support development of protocols that facilitate fixed-time AI in beef cattle. (Supported by USDA-NRI grant 2000-02163)

Key Words: Estrus synchronization, Progestin, Beef cows

1915 Evaluation of a fixed-time AI protocol for postpartum beef cows. G. A. Perry*, J. F. Bader, M. F. Smith, and D. J. Patterson, University of Missouri, Columbia, MO.

Treatment with the oral progestin, melengestrol acetate (MGA) prior to GnRH and $\text{PGF}_{2\alpha}$ effectively synchronizes estrus and maintains high fertility in postpartum beef cows. The objective of this experiment was to determine whether treatment with MGA prior to a GnRH- $\text{PGF}_{2\alpha}$ -GnRH protocol would improve pregnancy rates resulting from fixed-time AI. Multiparous crossbred cows at two University of Missouri farms (n=90 and n=137) were assigned by age and days postpartum (dpp) to one of two treatments: Cows were fed carrier (1.8-kg \cdot hd⁻¹ \cdot d⁻¹) with or without MGA (0.278-mg \cdot kg⁻¹) for 14 d. GnRH (100 μ g Cystorelin) was administered to all cows 12 d after MGA or carrier withdrawal and 7 d before $\text{PGF}_{2\alpha}$ (25 mg Lutalyse) injection. All cows received a second injection of GnRH and AI 72 h after $\text{PGF}_{2\alpha}$. Mean dpp for MGA and Control cows at the initiation of treatment were 39.6 and 38.9 for herd 1; and 51.9 and 50.9 for herd 2, respectively ($P > 0.05$ within herds). Blood samples were collected from all cows 10 d before and the day before MGA or carrier began, and at the time GnRH and $\text{PGF}_{2\alpha}$ were administered. Concentrations of P_4 in serum at the initiation of treatment were elevated (>1ng/ml) in 0% of MGA and 7% of Control cows in herd 1, and 54% of MGA and 49% of Control cows in herd 2 ($P > 0.05$ within herds). Pregnancy rates to fixed-time AI were determined by ultrasound 50 d after AI. Pregnancy rates in herd 1 were 58% (26/45) and 51% (23/45) for MGA-treated and Control cows, respectively ($P = 0.52$); and 63% (44/70) and 45% (30/67) for MGA-treated and Control cows in herd 2, respectively ($P < 0.03$). Differences in pregnancy rates to fixed-time AI remained significant ($P < 0.05$) when data from the two herds were combined [MGA=70/115 (61%); Control=53/112 (47%)]. There was no difference ($P > 0.2$) in final pregnancy rate between treatments, within herds, or combined. In summary, pregnancy rates resulting from fixed-time AI may be improved with treatment of MGA prior to a GnRH- $\text{PGF}_{2\alpha}$ -GnRH protocol. (Supported by grants from Select Sires, Inc. and USDA-NRI 2000-02163).

Key Words: Estrus synchronization, Fixed-time AI, Beef cows

1916 Stage of cycle effects on response to different GnRH + prostaglandin $\text{F}_{2\alpha}$ (PG) treatments in *Bos indicus* x *Bos taurus* cows. E. A. Hiers*, C. R. Barthle, J. K. Fullenwider, G. E. Portillo, MK. V. Dahms, J. M. Kramer, and J. V. Yelich, University of Florida.

Synchronization rate was evaluated using three different GnRH/PG protocols initiated on different days of the estrous cycle in *Bos indicus* x *Bos taurus* cows. Cows were presynchronized with a modified two-injection PG protocol (Lutalyse; 25 mg on d -14 and 12.5 mg on d -3 and -2 of experiment). Estrus was detected with HeatWatch[®]. After expression of estrus, cows were allotted to four groups based on day of the estrous cycle, d 2 (n = 15), 5 (n = 13), 12 (n = 12) and 18 (n = 13), when injected with GnRH (100 μ g i.m.; Fertagyl). At GnRH injection, cows within each day were randomly subdivided into one of three PG treatments 7 d later: 1) PG (25 mg i.m.; Lutalyse; n = 16); 2) split-PG (12.5 mg i.m. on d 7 and 8; Lutalyse; n = 18); and 3) cloprostenol (500 μ g i.m.; Estrumate; n = 19). At PG injection and every 48 h until

estrus and/or ovulation, a blood sample was collected and ovaries were examined by ultrasound. Cows treated with GnRH on d 18 tended ($P = 0.10$) to have a decreased 5-d estrous response (54%) compared with d 2, 5 or 12 (80, 77, and 92%, respectively). Interval from PG injection to onset of estrus was greater ($P \leq 0.05$) for d 18 (101 ± 15 h) compared with d 2, 5 or 12 (87 ± 12 , 82 ± 13 , 62 ± 12 h, respectively). Percentage of cows ovulating after PG was decreased ($P \leq 0.05$) for d 18 (38%) compared with d 2, 5 and 12 (100, 100, and 100%, respectively). The PG, split-PG, and cloprostenol treatments had similar ($P \geq 0.10$) 5-d estrous response (63, 89, and 74%, respectively) and percentage of cows with corpus luteum (CL) regression (81, 88, and 95%, respectively). Interval from PG injection to onset of estrus was similar for PG, split-PG and cloprostenol (90 ± 13 , 81 ± 11 , and 77 ± 11 h; respectively). In conclusion, stage of the estrous cycle when GnRH was administered affected response to PG. Although not significant, split-PG and cloprostenol treatments resulted in increased CL regression and estrous response in *Bos indicus* x *Bos taurus* cows.

Key Words: *Bos indicus*, estrus, GnRH

1917 Effects of exogenous GnRH infusion and steroid replacement on gonadotropins in ovariectomized nutritionally anovulatory cows. J.A. Vizcarra*¹ and R.P. Wettemann¹, ¹*Animal Science Department, Oklahoma Agricultural Experiment Station.*

Twenty-four nutritionally induced anovulatory ovariectomized cows were used to determine the effect of estradiol, progesterone, and exogenous GnRH pulses on LH and FSH in serum. Cows were randomly assigned to four 6 x 6 Latin Squares (LS). Control cows in LS 1 received a sham progesterone and estradiol vaginal insert. Cows in LS 2 were treated with a vaginal estradiol insert (E2), while cows in LS 3 received a progesterone insert (P4). Cows in LS 4 received an estradiol and progesterone vaginal insert (E2P4). Within each LS, cows were randomly assigned to six treatments in a 2 x 3 factorial. Doses of GnRH (0, 2 or 4 g) in 2 mL were infused at frequencies of once every h or once every fourth h for 2 d. Blood samples obtained every 10 min for 8 h on d 1 and d 2 and were analyzed for LH and FSH by RIA. In addition, blood samples were taken daily to evaluate progesterone and estradiol concentrations. Estradiol was increased from 0.1 0.1 pg/mL in control cows to 1.6 .1 pg/mL in the E2 insert treatment, and progesterone was increased from 0.1 0.1ng/mL to 2.3 0.1 ng/mL with the P4 insert. In the absence of exogenous GnRH, concentrations of LH were increased (39% greater than control; $P < 0.001$) while concentrations of FSH were reduced (34% less than control; $P < 0.01$) when ovariectomized nutritionally anovulatory cows were treated with E2, P4 or E2P4 inserts. Cows treated with a E2 and E2P4 insert had increased ($P < 0.03$) LH concentrations when either 2 or 4 g of GnRH was infused, compared with control cows. The GnRH-induced LH secretion was not increased when pulses were given every fourth h. Cows treated with a E2, P4, and E2P4 insert had decreased ($P < 0.04$) FSH concentrations when GnRH (2 g) was infused compared with control cows. However, only cows treated with a E2 and E2P4 insert had decreased ($P < 0.1$) FSH concentrations when GnRH (4 g) was infused compared with control cows. We concluded that estradiol, progesterone and GnRH pulses differentially regulate secretion of LH and FSH from the pituitary of beef cows.

Key Words: Bovine, GnRH, LH and FSH

1918 Vaginal electrical conductance for determining the timing of ovulation is also effective for monitoring rates of uterine involution in the postpartum dairy cow. S.D. Bowers*¹, B.S. Gandy¹, J. Spencer¹, K.B. Graves¹, A.B. Moore¹, and S.T. Willard¹, ¹*Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State, MS.*

The principle behind vaginal electrical conductance measurements (VEC) is that a change in the ionic balance of vaginal and cervical mucus occurs in response to cyclical changes in reproductive hormones. The objective of this study was to determine the efficacy of using VEC for monitoring not only follicular development and ovulation, but also uterine involution (UI) in dairy cattle postpartum (PP). In Experiment I, the applications of VEC for monitoring follicular development and ovulation using the Ovatest meter (Animark Inc.) were verified. Jersey cows ($n = 16$) were administered prostaglandin (PG; d 0) and sampled at 12 h intervals for 7 d post-PG. At each sampling period VEC

measurements (relative units; RU) were obtained, ultrasonography was used to measure follicular diameters, and serum samples collected for quantification of estradiol (E2) by RIA. Nine of the 16 cows that responded to PG ovulated within 7 d (56%) and were retained for further analysis. Ovulatory follicle size did not differ ($P \geq .10$) from PG to ovulation but increased (on average) 5.9 mm in size during this interval. While 2 of the 9 cows that ovulated exhibited variable E2 profiles post-PG, serum E2 decreased ($P \leq .01$) $3.1 \pm .84$ pg/ml in relation to ovulation ($n = 7$). Moreover, VEC measurements decreased ($P \leq .001$) 20.5 ± 4.5 RU between PG and ovulation. In summary for Experiment I, VEC decreased prior to ovulation and patterned, though not significantly, follicular growth and serum E2 through ovulation. In Experiment II, Jersey cows ($n = 11$) were sampled 2X/week from 1 to 60 d PP to assess the use of VEC for monitoring UI. On test days, VEC was recorded (Ovatest), follicular sizes and cross-sectional area of the pregnant vs. non-pregnant uterine horns captured (ultrasonography), and uterine tone scores assigned (UTS; rectal palpation). Uterine horn size differences were negatively correlated with UTS ($r = -.52$; $P \leq .001$) and VEC ($r = -.52$; $P \leq .001$); as uterine horn differences decreased over time PP, UTS and VEC measurements increased. Finally, UTS was also positively correlated ($r = .44$; $P \leq .01$) with VEC. These data suggest that VEC may be used as an objective tool for quantifying UI in dairy cattle.

Key Words: Vaginal electrical conductance, Uterine involution, Dairy cattle

1919 Pregnancy rates of lactating beef cows losing body weight during the breeding season. T. M. Towns*¹, M. D. Davis¹, M. E. Hockett¹, N. R. Rohrbach¹, and F. N. Schrick¹, ¹*Department of Animal Science, University of Tennessee, Knoxville.*

Effect of weight loss during the breeding season on reproductive performance was assessed in 150 beef cows. Cows were sorted by calving date, body condition (BCS; mean = 5.5), BW (mean = 510 ± 8 kg), age, and breed. Restricted (RES) cows were fed to lose 5% BW from d-30 to d 0 (start of breeding season), and an additional 10% BW from d 0 to d 60 (end of breeding season). Control (CON) cows were fed to maintain BW. All cows reinitiated cyclicity (progesterone ≥ 1 ng/mL) prior to start of the breeding season. Estrus was synchronized and cows were inseminated at estrus and 12 h later. Bulls were placed with each group after the synchronization period through the breeding season. Pregnancy was determined at d-30, 60, and 150. Measurements for BW, BCS, and blood samples for progesterone, insulin, nonesterified fatty acids (NEFA), and urea nitrogen (BUN) were collected weekly from d 30 to d 60. Body weight of RES cows decreased 56.9 kg; whereas, CON cows increased 10.8 kg from d-30 to d 60. Insulin decreased throughout the experimental period in RES cows (d-30, 0.33 ± 0.02 ng/mL; d 60, 0.24 ± 0.02 ng/mL; $P < 0.05$); however, NEFA (d -30, 0.77 ± 0.12 mEq/dL; d 60, 0.95 ± 0.12 mEq/dL; $P < 0.05$) and BUN (d -30, 20.4 ± 0.9 mg/dL; d 60, 29.1 ± 0.9 mg/dL; $P < 0.05$) increased. Neither estrous response (86.3 vs. 88.3%) nor conception rates (68.3 vs. 76.5%) differed between RES and CON cows, respectively. Pregnancy rates did not differ on d 30 (58.9 vs. 67.5%), d 60 (89.0 vs. 93.5%), or d 150 (91.8 vs. 96.1%) between RES and CON cows, respectively. Calves from RES cows had lower BW than CON at the end of the breeding season (145.4 ± 2.9 vs. 176.8 ± 2.9 kg; $P < 0.05$). In conclusion, cows which had reinitiated estrous cyclicity but were losing weight during the breeding season did not have reduced reproductive performance. These results suggest lower pregnancy rates associated with poor nutrition may be more related to failure of animals to reinitiate postpartum cyclicity rather than inability to establish and maintain pregnancy.

Key Words: Nutrition, Body weight, Pregnancy

1920 Use of doppler ultrasonography to estimate fetal age and monitor fetal heart rate and uterine artery pulse rate in dairy cattle. S. Willard¹, A. Webb*¹, S. Bowers¹, and B. Gandy¹, ¹*Department of Animal and Dairy Sciences, Mississippi State University, Mississippi State, MS 39762.*

The objective of the present study was to evaluate the use of Doppler ultrasonography (US) to monitor both uterine blood flow and fetal heart rate (FHR) during pregnancy in dairy cattle. Possible applications of Doppler US include the monitoring of fetal distress when a pregnancy becomes compromised, or as a method for estimating fetal age through changes in FHR during gestation. In this study, 30 pregnant Holstein

heifers were sampled repeatedly between 54 to 262 d post-breeding. On test days, transrectal Doppler US (Medata Systems) was performed to quantify FHR and dam uterine artery pulse rates (UAP). Following Doppler US, B-mode US was performed to obtain placentome diameter measurements as an additional measure of pregnancy stage. For the 104 total individual tests, 48 FHR, 101 UAP and 78 placentome measurements were obtained. Doppler US was also linked to a PowerLab Chart Recorder (ADI Instruments) to record FHR and UAP wave-forms for analysis. Data were analyzed using correlation and regression analysis relative to stage of gestation. Fetal heart rate was negatively correlated ($r = -.61, P \leq .01$) with d of gestation. Fetuses that were ≤ 140 d of age had higher ($P \leq .01$) FHR (155.8 ± 3.2 beats per minute; BPM) than fetuses ≥ 140 d of age (142.8 ± 2.4 BPM). As expected, average placentome size was positively correlated ($r = .83; P \leq .01$) with d of gestation. However, UAP of the dam did not change ($r = .16; P \geq .10$) relative to d of gestation (mean: 74.1 ± 1.0 pulses per minute). Of the 104 attempts at Doppler US, FHR were determined 46% of the time and UAP found 97.1% of the time. Using the PowerLab, FHR wave-forms (gestation d 140 to 145) varied 808.0 ± 13.9 mV in amplitude from baseline (62.9 ± 5.9 mV), at a frequency of 150 BPM. In contrast, UAP signatures were not different ($P \geq .10$) from background levels (81.2 ± 3.2 MAX mV; 44.8 ± 3.1 MIN mV). In summary, transrectal Doppler US is effective for estimating fetal age in the bovine and for monitoring FHR characteristics. However, assessments of uterine blood flow using standard transrectal Doppler US will require additional investigation to detect changes in uterine blood flow under varied conditions. [This project was part of an undergraduate directed individual study program].

Key Words: Doppler ultrasonography, Fetal heart rate, Dairy cattle

1921 Factors affecting temporal relationships between estrus, ovulation and insemination in a commercial sow herd. B. A. Belstra*, W. L. Flowers, K. J. Rozeboom, and M. T. See, *North Carolina State University, Raleigh, NC.*

Our objective was to examine the effect of genotype (A, B, C), lactation length (11 to 20 d), parity (1, 2, ≥ 3), weaning-to-estrus interval (WEI; 3, 4, 5, ≥ 6 d) and season (spring, summer) on the estrus, ovulation and subsequent fertility characteristics of sows. Duration of estrus and time of ovulation were estimated via boar exposure and transabdominal real-time ultrasonography, respectively, every 6 h from 2 to 10 d postweaning in 174 sows (87/season). The mean and range of duration of estrus (DE) and onset of estrus-to-ovulation interval (EOI) was 58.1 h, 24 to 84 h and 44.1 h, 12 to 90 h, respectively. Genotype, lactation length and parity did not affect DE or EOI ($P > .18$). There was a stepwise decrease in DE as WEI increased from 3 to 5 d ($P < .03$) but not 5 to ≥ 6 d ($P > .3$). Sows weaned in the spring compared to the summer had a shorter DE (53.1 vs. 60.8 h, $P < .001$) and a shorter EOI (38.1 vs. 48.5 h, $P < .001$). Sows were inseminated on an 8 am d 1 of estrus, 8 am and 3 pm d 2 of estrus schedule. Variation in WEI, DE and EOI resulted in insemination-to-ovulation intervals with a mean and range of 35.9 h, 87 to - 3 h; 12.0 h, 63 to - 27 h and 4.8 h, 56 to - 34 h, for services 1, 2 and 3, respectively. Only season affected insemination-to-ovulation intervals ($P < .001$) but there was no difference in spring vs. summer number of inseminations within 24 h prior to ovulation (1.3 vs. 1.3, $P > .9$), conception rate (94.6 vs. 90.5%, $P > .3$), farrowing rate (91.9 vs. 86.5%, $P > .3$) or pigs born alive (11.0 vs. 10.9, $P > .9$). Sows that received 0 vs. 1 or 2 inseminations within 24 h prior to ovulation had a similar conception and farrowing rate ($P > .7$) but tended to have fewer pigs born alive (9.5 vs. 11.3, $P < .09$). In this particular herd, season and weaning-to-estrus interval altered duration of estrus and time of ovulation. However, these changes were not large enough to affect sow fertility because the multiple insemination schedule in place ensured that at least one insemination occurred near ovulation.

Key Words: Estrus, Ovulation, Sow

1922 Hormonal Changes After Manual Rupture of Follicular Cysts. Ahmet Gumen* and Milo C. Wiltbank, *Department of Dairy Science, University of Wisconsin-Madison.*

Follicular cysts are commonly treated by manual rupture. In this study, we induced follicular cysts by causing a GnRH/LH surge with 5 mg estradiol benzoate (EB; produces circulating estradiol = 67 pg/ml) at a time when a dominant follicle was not present on the ovary (Day 0).

After treatment 8 of 20 (40%) cows developed a large follicle anovulatory condition similar to follicular cysts. On Day 10, cows were again challenged with EB. Six of 8 cows had no detectable LH surge but 2 cows had some LH increase (8 and 3 ng/ml) after EB. At Day 50, cows were randomized into 2 groups: Manual Rupture (MR; n=4), Control (n=4). MR cows had all follicles ≥ 15 mm removed by exerting pressure through the rectum similar to what is done routinely in the field. Prior to treatment all cows had periodic (every 15-25 d) development of large anovulatory follicles and corresponding increases in circulating estradiol. At MR, 2 cows had elevated estradiol (12 and 29 pg/ml) that decreased to basal concentrations after MR. There was a subsequent surge in FSH and emergence of a new follicular wave. Two MR cows had basal estradiol and a follicular wave was emerging at the time of MR. There was no FSH surge in these cows following MR. Two cows (one control and one MR) had a spontaneous double ovulation at Days 56 and 57. These ovulating cows were the same 2 cows that had an LH increase in response to EB at Day 10. The remaining 6 cows were challenged with EB on Day 71. Two of the cows (one control and one MR) had an LH surge and ovulation in response to EB; while 4 had no LH surge and no ovulation. The non-ovulating cows were treated for 7 d with progesterone (CIDR on Days 78-85) followed by EB on Day 86. All four cows had an LH surge and ovulation in response to EB. Thus, MR can remove functional large anovulatory follicles and start a new follicular wave. However, MR does not appear to resolve the underlying physiological problem that cystic cows do not have an LH surge following high circulating estradiol. Progesterone treatment can resolve this physiological problem.

Key Words: Follicular Cysts, Manual Rupture, Estradiol

1923 Pregnancy rates in lactating dairy cows following timed embryo transfer under heat stress conditions. Y.M. Al-Katanani*¹, M. Drost¹, R.L. Monson², J.J. Rutledge², C.E. Kringer III¹, J. Block¹, and P.J. Hansen, ¹University of Florida, Gainesville, FL/USA, ²University of Wisconsin, Madison, WI/USA.

Timed embryo transfer (TET) using in vitro-produced (IVP) embryos without estrus detection can be used to reduce adverse effects of heat stress on fertility. One limitation is the poor survival of IVP embryos to cryopreservation. Objectives were to 1) confirm beneficial effects of TET on pregnancy rate during heat stress as compared to timed artificial insemination (TAI) and 2) determine the efficacy of vitrification as a method for cryopreservation. For vitrified embryos (TETV), vitrification and thawing procedures, using excellent and good quality d 7 Holstein blastocysts, were as described (Theriogenology 50:129). For fresh embryos (TETF), Holstein oocytes were shipped from Wisconsin to Florida overnight, fertilized and embryos cultured in modified KSOM for 7 d using the method for production of vitrified embryos. Excellent and good quality blastocysts on d 7 were transported to the cooperating dairy in a portable incubator. Non-pregnant, lactating Holsteins (n=155) were injected with GnRH (100 μ g, im), followed 7 d later by PGF_{2 α} (25 mg, im) and GnRH (100 μ g) on d 9. Cows in the TAI group (n=68) were inseminated the next day with semen from a single bull that was also used to produce embryos. Cows in the other groups (n=33 for TETF and 54 for TETV) received an embryo on d 7 after anticipated ovulation (d 8 after second GnRH). The proportion of cows that responded to synchronization (plasma progesterone ≤ 1.5 ng/ml on d 0 and ≤ 1.5 ng/ml on d 8 after GnRH) was 67.7%. Pregnancy rate for all cows at d 45 was higher ($p < 0.05$) in the TETF group than for the TAI and TETV groups (19.0 \pm 5.0%, 6.2 \pm 3.6%, and 6.5 \pm 4.1%). For cows responding to synchronization, pregnancy rate was higher ($p < 0.05$) for TETF than for other groups (26.7 \pm 6.4%, 5.0 \pm 4.3%, and 7.4 \pm 4.7%). In conclusion, ET of fresh IVP embryos can improve pregnancy rate under heat stress conditions but pregnancy rate following transfer of vitrified embryos was no better than TAI.

Key Words: Heat stress, Embryo transfer, Vitrification

1924 Factors affecting the time intervals between estrus, LH surge and ovulation in high-yield dairy cows. A. Bloch*¹, D. Wolfenson¹, M. Kaim², Z. Roth¹, R. Braw-Tal², and Y. Folman², ¹Faculty of Agriculture, Hebrew University, Rehovot, Israel, ²Agricultural Research Organization, Bet-Dagan, Israel.

The short fertile lives of the male and female gametes in the female tract necessitate accurate timing of insemination. We examined the effects of season, parity, milk yield, body condition, and concentrations of steroids

and LH surge prior to estrus, on the intervals: estrus-ovulation (E-O), estrus-LH surge (E-LH), and LH surge-ovulation (LH-O), and on post-O progesterone curves. Holstein cows (n=74) in first-fifth lactation, yielding 35-57 kg milk/day (d), were examined at 60-80 d postpartum. After synchronization, cows were examined around subsequent spontaneous E. Blood samples were taken every 2 d in cycles before and after E, and every 3 to 8 h around E and expected O. Cows were watched for E continuously for 5 d from the expected time of E. From 20 h after standing E, time of O was checked by ultrasound every 4 h. For most cows (73%), with E-O<30 h, E-O, E-LH and LH-O intervals were 27±0.3, 2.3±0.4 and 24±0.4 h, respectively (normal interval; meansem); 17% of cows had a 31-35 h E-O (long interval) and 10% (n=7) ovulated 35 to >50 h after E (43±2.6 h; very long interval). E-O, E-LH and LH-O intervals were not affected by season, parity, milk yield, milk composition or body condition. LH surge amplitude in very-long interval group reached 40% of those in other groups (P<0.01). Concentrations of estradiol prior to LH surge tended to be lower (P<0.08), and those of progesterone prior to E were lower (P<0.03) in the very-long than in the other two groups. Post-O progesterone curves were lower in long and very-long than in normal interval group (P<0.03). The data show a subgroup of cows with extended E-O interval, associated with low plasma steroid concentrations and low LH surge prior to O, and with low post-O progesterone, which may result in non-optimal timing of insemination, lowering fertilization rate and leading to low fertility.

Key Words: Estrus, Ovulation, LH surge

1925 Hormonal induction of enhanced removal of impaired follicles improved oocyte quality in the autumn in previously heat-stressed cows. Z. Roth*¹, A. Arav², A. Bor², R. Braw-Tal², and D. Wolfenson¹, ¹Faculty of Agriculture, Hebrew University, Rehovot, Israel, ²Agricultural Research Organization, Bet Dagan, Israel.

The autumn conception rate of dairy cattle is low although cows are relieved from summer heat stress. Previously, frequent follicular aspirations in the autumn improved oocyte quality, therefore, the present study examined different hormonal approaches to oocyte quality improvement in autumn by enhanced removal of follicles damaged in the previous summer. In two experiments intended to examine different hormonal treatments, follicles (3-8 mm) were aspirated in the autumn from lactating Holstein cows on day (d) 4 of each cycle by the ovum pick up procedure. Oocytes were morphologically examined, matured in vitro, activated and cultured for 8 d. In the first experiment, recombinant bovine somatotropin (500 mg; bST, Sometribove) was injected into cows (n=8) every 14 d, during 4 estrous cycles. Before bST treatment (cycle 1) percentages of grade-I and cleaved oocytes did not differ between control (n=8) and bST groups, and parthenogenetic blastocysts were nil. Treatment with bST increased grade-I oocyte percentages, compared with control cows (P<0.05), particularly in cycle 2 (72 vs. 26%), less so in cycles 3 and 4 (55 vs. 42%). Cleavage and blastocyst rates gradually rose in cycles 3 and 4, but did not differ between groups. In the second autumn experiment, two doses of FSH (2x200 mg; Follotropin V) were injected at 12-h interval (FSH; n=3) on d 5 and on d 11 of cycle 1. In cycle 1 (before FSH injection), grade-I oocyte (52%) and cleavage (24%) rates did not differ between control (n=4) and FSH groups. In the next cycle, grade-I oocyte and cleavage rates were higher in FSH than in control group (89 vs. 51% and 85 vs. 31%, respectively; P<0.05). Results indicate that a short treatment with bST or FSH in the autumn improved oocyte quality; perhaps recruitment of more growing follicles into follicular waves enhanced the removal of follicles damaged in the previous summer.

Key Words: bST, FSH, Oocyte

1926 Follicular dynamics and concentrations of steroids and gonadotropins in lactating cows and nulliparous heifers. G. Inbar¹, D. Wolfenson*¹, Z. Roth¹, M. Kaim², A. Bloch¹, and R. Braw-Tal², ¹Faculty of Agriculture, Hebrew University, Rehovot, Israel, ²Agricultural Research Organization, Bet Dagan, Israel.

Differences between lactating cows (C) and nulliparous heifers (H) in follicular development and circulating hormone concentrations, that may relate to differences in fertility between the groups, were examined. Multiparous Holstein C (n=19) at 77±7 (meansem) days (d) post-partum,

yielding 49±2.4 kg milk/d and H (n=20), 13.3±1 months old, were examined in 2 replicates during 1 estrous cycle, by ultrasound monitoring every 2 d and daily blood samples. Fifteen C (79%) and 14 H (70%) had 2-follicular-wave cycles, 4 C and 5 H had 3-wave cycles and 1 H had a 4-wave cycle. Cycle length was shorter in H than in C, and in 2- than in 3- and 4-wave cycles, both by 2.5 d (P<0.02). Size of ovulatory follicle (F) and number of large Fs in the follicular phase were smaller in H than in C (13.1±3 vs. 16.5±5 mm; P<.001; and 1.0.1 vs. 1.9.1 Fs; P<.01), in both wave cycles. Emergence of preovulatory F was earlier in H than in C (10.2±.7 vs. 12.5±.5 d; P<.01), in 2-wave cycles, and similar (17.1±.8) in 3-wave cycles. Dominance duration of ovulatory F was longer in 2-wave than in 3-wave cycles (7.0±.5 vs. 4.6±.8 d; P<.01), similar in C and H in replicate 1, but shorter in H than in C in replicate 2 (5.1±1.0 vs. 9.1±1.5 d; P<.05). Estradiol concentrations were higher around estrus in H than in C, peaking at 10.1±.7 vs. 7.1±.8 pg/ml (P<.01). Progesterone concentrations were higher in H than in C from d 2 to d 16 of cycle (P<.01). LH surges were higher and wider in H than in C, peaking at 19.0±4.2 vs. 8.6±1.8 ng/ml (P<.01). The timing of FSH surge concentrations corresponded well to the emergence of follicular waves in both H and C. Basal and peak surge values of FSH were 15 to 20% lower in H than in C (P<0.05). Results show differences in ovarian functions and gonadotropins secretion that may account for the differences in fertility between nulliparous heifers and multiparous lactating cows.

Key Words: Follicular dynamics, Cows, Heifers

1927 Effects of fertilizing bovine oocytes with sperm aged post-thaw. J.A. Miller*, F.N. Schrick, A.M. Saxton, and J.L. Edwards, *The University of Tennessee, Knoxville, TN, USA.*

The present study examined development of bovine embryos derived from oocytes fertilized with aged sperm. Cumulus oocyte complexes were matured 22.5 h and fertilized with percoll-purified sperm (750,000 sperm/mL). Before percoll-purification, sperm was treated in the following manner: prepared within 1 h post-thaw (control), aged for 8 or 14 h post-thaw at 34.4°C in a H₂O bath, or aged 23 h post-thaw at 4°C in a refrigerator. Spermatozoa from nine bulls, representing various breeds, were evaluated. Proportion of motile sperm was assessed after aging and following percoll-purification. Number of putative zygotes (PZ) that cleaved and developed to blastocyst was evaluated on d 3 and 8 post-fertilization, respectively. Data were arranged in a randomized block design and analyzed using mixed models of SAS. Aging sperm in a H₂O bath for 14 h at 34.4°C or in a refrigerator for 23 h at 4°C reduced proportion of motile sperm when compared to control or sperm aged in a H₂O bath for 8 h post-thaw at 34.4°C (42.1 and 56.8% vs 69.2 and 64.9%, respectively; P < 0.0001; SEM = 4.1). Overall, proportion of motile sperm increased after percoll-purification (53.0 vs 64.6%; P < 0.03; SEM = 5.1) but remained lower for sperm aged at 34.4°C for 14 h (77.3 and 69.3% for control and refrigerated sperm, respectively vs 48.9%; P < 0.07; SEM = 8.8). Fertilization of oocytes with sperm aged for 14 h at 34.4°C reduced proportion of PZ that cleaved, but did not alter ability of embryos to develop to 8-16-cell or blastocyst (Table). Although reducing number of motile sperm is a negative effect of aging post-thaw, results demonstrate that developmentally competent embryos can be obtained. Aging is of concern but inevitable when attempting to manipulate sperm post-thaw after fertilization.

Treatments	Reps	# PZ	Cleaved	8-16-Cell*	Blastocyst*
Control	9	310	76.8 ^a	89.7	30.1
34.4°C, 8 h	4	106	74.8 ^{ab}	85.2	30.6
34.4°C, 14 h	8	317	63.7 ^b	81.1	41.1
4°C, 23 h	5	375	76.8 ^{ab}	87.8	30.9
P-value	—	—	0.0592	0.2000	0.2994
SEM	—	—	6.4	3.5	6.6

*Proportion of cleaved embryos developing to 8-16-cell and blastocyst

Key Words: Sperm, Aging, Bovine

1928 Evaluation of the fertility potential of extended cooled equine spermatozoa using the resazurin reduction test and NADH₂. W. T. Campbell*, S. A. Ericsson, J. S. Pendergraft, K. K. Korth, and J. A. Pitchford, *Sul Ross State University, Alpine, Texas.*

The objective of this study was to determine if the fertility potential of extended cooled equine semen samples could be assessed using the resazurin reduction test supplemented with NADH₂. Semen samples (n=30) from 7 mature stallions were collected using a Missouri style artificial vagina with the gel-free fraction of each sample being evaluated microscopically (250X) with a Makler counting chamber. Samples that contained at least the minimal concentration (20 X 10⁶/mL), total number motile (10 X 10⁶/mL), and number of progressively motile (5 X 10⁶/mL) spermatozoa recommended for a 50 mL insemination dose were extended (1:4 ratio) in Kenney's skim milk with Gentamicin Sulfate to 50 mL and cooled to 5°C. At 32, 56, and 80 h post-extension, 7 (1 mL) aliquots were removed and allowed to warm at 23°C for 30 min. One aliquot was analyzed microscopically to determine if the sample retained the recommended sperm numbers. The remaining aliquots were divided equally into control aliquots (no NADH₂) and treatment aliquots (0.5 mg NADH₂/aliquot). Resazurin (50 µL of a 6.77 µM solution) was added to each of the aliquots and the time of reduction of resazurin (blue) to resorufin (pink) was recorded up to a maximum of 30 min. Diagnostic statistics were utilized to assess the accuracies of the two groups. None of the control aliquots reduced resazurin (30 min) at 32, 56, and 80 h. The treatment aliquots at 32 h reduced resazurin at 20.5 min with a 75% sensitivity (Sen), 96% specificity (Spec), 75% positive (PPV) and 96% negative (NPV) predictive values, and 93% overall accuracy (ACC). Resazurin was reduced by the 56 h treatment aliquots at 17.5 min with a 46% Sen, 94% Spec, 86% PPV, 70% NPV, and 73% ACC. The 80 h treatment aliquots reduced resazurin at 16.5 min with a 69% Sen, 100% Spec, 100% PPV, 81% NPV, and 87% ACC. These results suggest that the resazurin reduction test supplemented with NADH₂ can accurately assess the fertility potential of extended cooled equine semen.

Key Words: Spermatozoa, Resazurin, NADH₂

1929 Motility of frozen-thawed bovine sperm after aging for extended time periods. M.N. Malone*, J.A. Miller, A.M. Saxton, and J.L. Edwards, *The University of Tennessee, Knoxville, TN, USA.*

The objective of the present study was to evaluate effects of aging frozen-thawed bovine sperm. Specifically, sperm motility was evaluated after aging frozen-thawed sperm for an extended time period in nine bulls representing Charolais, Holstein, and Senepol breeds (n = 3 bulls/breed). Straws of frozen sperm were thawed and maintained in a water bath at 34.5°C. Sperm motility was assessed at 0, 5, 7, 9, 11, 13, and 15 h post-thaw. Spermatozoa were diluted 1:20 in Sperm-TALP containing 6.0 mg/mL BSA, 1.0 mM sodium pyruvate, 50 U/mL of penicillin, and 50 µg/mL of streptomycin. Motility of sperm was assessed independently by two individuals. The experiment was replicated three times. Statistical models were fit to include effects of breed, individual bulls, and time as either a class or regression variable. Motility of frozen-thawed sperm decreased from 68.3% immediately post-thaw to 34.7% 15 h later (SEM = 2.5; P < 0.0001). Averaged over time, sperm motility was lowest in Charolais bulls (41.1%) compared to Holstein (51.9%) and Senepol (55.3%; SEM = 2.1; P < 0.0001). Ability of sperm to withstand stress of aging post-thaw differed according to breed. Regressing over time, motility of frozen-thawed sperm from Charolais and Holstein bulls decreased more rapidly (slope = -2.8 and -2.5% per hour, respectively) than for Senepol bulls (slope = -1.4% per hour; SEM = 0.4; P < 0.0002). The rate of decline in motility of aged sperm was very similar for three Senepol bulls examined (slope = -1.7, -1.3 and -1.2% per hour; SEM = 0.4; P > 0.7). In contrast, large amounts of variation among individual bulls were noted in Holsteins (slope = -4.2 and -3.0% versus -0.6% per hour; SEM = 0.4; P < 0.0001) and Charolais (-3.8% versus -2.6 and -2.1% per hour; SEM = 0.4; P < 0.02). Results demonstrated motility of sperm of individual bulls within a breed differed in ability to handle stress of aging. Future efforts will focus on determining if ability of sperm to withstand stress can be used as an indicator of fertility.

Key Words: Sperm, Motility, Aging

1930 Effects of growth hormone (GH) and IGF-I on development of in vitro derived bovine embryos. F. Moreira, F. F. Paula-Lopes, P. J. Hansen, L. Badinga, and W. W. Thatcher, *University of Florida.*

Objectives were to determine if addition of GH to maturation medium and GH or IGF-I during embryo culture affects development of bovine embryos. Cumulus oocyte complexes (COCs) from slaughterhouse ovaries were matured in 50 µL drops of serum-free TCM-199 medium containing FSH (20 µg/ml) and estradiol (2 µg/ml) in groups of 10 oocytes per drop. During maturation, COCs were treated with 100 or 0 ng/ml of GH. COCs were inseminated, denuded, and transferred to 25 µL drops of serum-free KSOM medium containing essentially fatty acid-free bovine serum albumin (2 mg/ml) in groups of 10 presumptive embryos per drop for culture (d 0). Beginning at d 0, the following treatments were added to medium: 1) non-specific IgG (raised to heat shock protein 65 of *Mycobacterium bovis*; 10 µg/ml), 2) GH (100 ng/ml) plus IgG (10 µg/ml; GH/IgG), 3) IGF-I (100 ng/ml) plus IgG (10 µg/ml; IGF/IgG), 4) antibody to IGF-I (10 µg/ml; anti-IGF), 5) GH (100 ng/ml) plus anti-IGF (10 µg/ml; GH/anti-IGF), 6) IGF-I (100 ng/ml) plus anti-IGF (10 µg/ml; IGF/anti-IGF), or 7) no further additions (control). Embryos were observed at d 3 for cleavage and at d 7 and 8 for blastocyst development. The experiment was replicated on 6 occasions. Addition of GH to the maturation medium increased cleavage rates at d 3 compared to control (87.3 ± 1.2 % > 83.9 ± 1.2 %; P < 0.05) but had no effects on blastocyst development at d 7 and 8. Blastocyst development was greater (P < 0.1) for GH/IgG (16.2 ± 1.8 %) and IGF/IgG (16.5 ± 1.8 %) than for IgG (8.7 ± 1.5 %) at d 7. At d 8, blastocyst development was greater (P < 0.01) for GH/IgG (24.8 ± 2.5 %) and IGF/IgG (33.7 ± 2.5 %) than for IgG (16.1 ± 2.1 %) and greater for IGF/IgG than for GH/IgG (P < 0.02). Blastocyst development at d 8 did not differ between anti-IGF (20.4 ± 1.8 %) compared to GH/anti-IGF (24.1 ± 1.9 %) and IGF/anti-IGF (17.7 ± 1.9 %), but it was greater for GH/anti-IGF than for IGF/anti-IGF (P < 0.05). Both GH and IGF-I stimulated embryonic development and GH effects seem to be independent from IGF-I.

Key Words: Bovine IVF, GH, IGF-I

1931 Nuclear progression of bovine oocytes maintained at germinal vesicle stage up to 66 hours using roscovitine. A.M. Clarke*, L.M. McCann, and J.L. Edwards, *The University of Tennessee, Knoxville, TN, USA.*

The objective of this study was to determine effectiveness of roscovitine (inhibitor of p34^{cdc2}/cyclin B kinase) to maintain bovine oocytes at germinal vesicle (GV) stage for 21, 42 or 66 h after removal from follicles without compromising subsequent progression to metaphase II (MII). Cumulus oocyte complexes were cultured with 50 µM roscovitine for 21, 42, or 66 h in 5.5% CO₂ at 38.5°C in M199 containing 10% fetal bovine serum, 1 X nucleosides, 2 mM L-glutamine, 1 X nonessential amino acids, 0.1 mM β-mercaptoethanol, 50 U/mL penicillin, and 50 µg/mL streptomycin. After 21, 42, or 66 h, oocytes were divided within treatment: nuclear status was determined in approximately half while those remaining were washed of roscovitine and cultured for an additional 24 h in medium containing 0.3 µg/mL LH and 5.0 µg/mL FSH. Nuclear status of oocytes was evaluated using Hoechst staining. Number of oocytes with a GV, metaphase I (MI), anaphase I, telophase I, or MII configuration was recorded. Data were arranged in a randomized block design and analyzed using mixed models of SAS. Culture of oocytes with roscovitine, up to 66 h after removal from follicles, maintained >90% at GV stage (Table). Moreover, culture of oocytes with roscovitine for 21 or 42 h after removal from follicles, did not alter proportion progressing to metaphase II after placement in gonadotropins (Table). Inhibiting resumption of meiosis for extended time periods in oocytes after removal from follicles will be important for development of culture systems allowing for the study of immature oocytes.

Time in Roscovitine (h)	Oocytes*		Matured Oocytes**		Reps	GV (%)	MI (%)	MII (%)
	Reps	Oocytes*	GV (%)	Oocytes**				
21	4	155	94.8	109	3	17.4	11.7	69.2 ^a
42	4	167	96.2	148	4	11.9	10.9	70.4 ^a
66	4	185	90.7	167	4	21.6	14.8	52.1 ^b
SEM	—	—	1.8	—	—	3.8	4.5	5.5
P-Value	—	—	0.1	—	—	0.2	0.8	0.04

*Number of oocytes placed in medium containing gonadotropins after culture with roscovitine. *Number of oocytes cultured with roscovitine and evaluated for presence of GV.

Key Words: bovine, oocyte, roscovitine

1932 Postweaning growth and puberty of Angus and Romosinuano bulls in Florida. C. C. Chase, Jr.*¹, R. E. Larsen², P. C. Sheerin², M. J. Williams¹, A. C. Hammond³, T. A. Olson², and S. W. Coleman¹, ¹USDA, ARS, Brooksville, FL, ²University of Florida, Gainesville, ³USDA, ARS, Athens, GA.

Postweaning growth and puberty were determined from two consecutive calf crops using Angus (A; yr 1: n = 17, 254±15.9 d, 214±6.6 kg; yr 2: n = 12, 264±7.3 d, 221±11.4 kg) and Romosinuano (R; yr 1: n = 18, 259±15.4 d, 222±6.4 kg; yr 2: n = 24, 232±5.1 d, 182±8.0 kg) bull calves. Following weaning and preconditioning, bulls were managed as a single group on mixed bahiagrass and perennial peanut pastures (and hay) and fed 4.5 kg/d concentrate for 357 to 358 d. At the start of the study and at 28-d intervals, BW, hip height (HH), and scrotal circumference (SC) were measured. Concurrently, when the SC of a bull reached 23 cm, semen collection was attempted by electroejaculation. Ejaculates were evaluated for presence of first spermatozoa (FS), 50 million sperm with at least 10% motility (PU), and 500 million sperm with at least 50% motility (PP). In yr 1, R gained more BW (P < 0.05; 308±7.8 vs 281±8.1 kg), HH (P < 0.05; 26±0.9 vs 23±0.9 cm), and SC (P < 0.10; 13.0±0.6 vs 11.5±0.6 cm) than A bulls. In yr 2 when R were (P < 0.05) younger, lighter, and had smaller SC at the start of the study than A bulls, gains in BW and HH did not differ between R vs A (264±7.5 vs 283±10.7 kg and 22±1.0 vs 21±1.4 cm); however, R had greater (P < 0.001) gains in SC (14.5±0.4 vs 10.9±0.6 cm). In yr 1, breed (R vs A) did not affect (P > 0.10) age at FS (336±18.6 vs 306±19.2 d), PU (357±19.6 vs 339±20.2 d), or PP (397±19.4 vs 362±19.9 d); however, R were heavier (313±10.6 vs 267±11.0, 336±11.2 vs 297±11.6, and 378±11.4 vs 320±11.7 kg) and taller than A at FS, PU, and PP, respectively. Breed did not affect SC at FS and PU, but R tended (P < 0.10) to have a larger SC at PP (30.2±0.5 vs 28.9±0.5 cm). In yr 2, R tended (P < 0.10) to be older than A at FS (356±10.2 vs 325±14.6 d), but not (P > 0.10) at PU (378±10.5 vs 352±15.0 d) and PP (408±11.8 vs 408±16.7 d). In yr 2, breed did not affect BW at FS (250±7.4 vs 258±10.5 kg) or PU (266±9.4 vs 283±13.3 kg), but R tended (P < 0.10) to be lighter than A at PP (291±11.0 vs 328±15.7 kg), and R were taller (P < 0.001) than A at FS, PU, and PP. Romosinuano had smaller (P < 0.05) SC than A at FS and PP, but similar SC at PU (25.7±0.4 vs 26.7±0.6 cm). In conclusion, the tropically adapted R bulls reached puberty at similar ages as A bulls when reared in the subtropics.

Key Words: Bulls, Tropics, Puberty

1933 Concentrations of LH and testosterone in serum of sexually mature boars treated with naloxone. M.J. Estienne*¹, A.F. Harper¹, J.W. Knight¹, G.B. Rampacek², and C.R. Barb³, ¹Virginia Polytechnic Institute and State University, Blacksburg, ²University of Georgia, Athens, ³USDA-ARS, Athens, GA.

Treatment of gilts and sows with naloxone, an endogenous opioid receptor antagonist, increases LH secretion, presumably as a consequence of increased GnRH release (Barb et al., 1991; *Domest. Anim. Endocrinol.* 8:15-27). The objective of the current study was to determine the effects of naloxone on circulating concentrations of LH and testosterone in sexually mature boars. Five littermate boars (Landrace x Yorkshire; 186.9 ± 8.3 kg BW and 289 d of age), fitted with indwelling jugular vein catheters, were used. Beginning 24 h after catheterization, blood samples were collected at 15-min intervals for three hours. Two h after initiation of blood sampling, boars received an i.v. challenge of naloxone hydrochloride (Sigma Chemical Co., St. Louis, MO; 1 mg/kg BW; n = 2) or .9% saline (n = 3). Twenty-four h later the experiment was repeated, but boars that previously received naloxone received .9% saline and vice versa. Serum concentrations of LH and testosterone were not affected by day of experiment (P > .1). Prior to i.v. injections, LH concentrations in serum were similar (P > .1) between groups and averaged 0.56 ± 0.03 ng/mL. Naloxone increased (P < 0.01) LH concentrations, with peak values of 1.75 ± 0.22 ng/mL occurring 45 min after treatment. Injection of .9% saline had no effect (P > 0.1) on LH secretion. Serum testosterone concentrations averaged 1.94 ± 0.23 ng/mL prior to naloxone and increased (P < 0.01) to 3.06 ± 0.23 ng/mL by 1 h after treatment. Testosterone levels averaged 3.24 ± .23 ng/mL before .9% saline and decreased (P < .04) to 2.52 ± 0.23 ng/mL by 1 h after

injection. In summary, naloxone increased serum LH and testosterone concentrations. Our results are consistent with the theory that endogenous opioid peptides suppress LH secretion in sexually mature boars.

Key Words: LH, testosterone, boars

1934 Early postnatal concentrations of plasma testicular steroid hormones as indicators of boar taint in market weight pigs. P.A. Sinclair*, E.J. Squires, and J.I. Raeside, University of Guelph, Guelph, Ontario, Canada.

If a relationship existed between levels of testicular steroids present in early postnatal pigs, and those present at market weight, then plasma steroid concentrations in young pigs could be used as an indicator of boar taint at market weight. Blood samples were taken from 75 Yorkshire boars at days 14, 21, and again at a market weight of 110 kg. Positive correlations were found between the concentrations of fat androstenone at market weight and the concentrations of plasma androstenone (r = 0.46; P < 0.01), estrone sulfate (r = 0.42; P < 0.01), and testosterone (r = 0.26; P < 0.05) at market weight. Significant correlations were observed between plasma testosterone concentrations at market weight and plasma concentrations of androstenone (r = 0.57; P < 0.05), and estrone sulfate (r = 0.49; P < 0.05) in early postnatal animals. However, concentrations of androstenone in fat of market weight animals were not correlated with plasma concentrations of estrone sulfate, androstenone or testosterone in early postnatal animals. This suggests that early postnatal plasma steroid production has no relationship with levels of market weight testicular steroids and cannot be used to predict the potential for boar taint. Additional findings of this study revealed that in market weight animals, a negative correlation (r = - 0.57; P < 0.01) between backfat thickness and concentrations of androstenone in fat was present. Animals were subsequently sorted according to backfat thickness into lean and fat groups of animals. There was a strong, negative correlation between backfat thickness and androstenone concentrations in fat (r = - 0.80; P < 0.01), as well as a positive correlation between plasma androstenone and concentrations of androstenone in fat (r = 0.42; P < 0.05) among the lean group of animals. This suggests that the accumulation of androstenone from plasma into fat may be affected by other factors than the hydrophobicity of androstenone, such as carcass leanness.

Key Words: Boar taint, Androstenone, Postnatal

1935 Vitamin supplements and reproductive performance in boars. I. Audet*¹, J. -P. Laforest², G. -P. Martineau³, and J. J. Matte¹, ¹Agriculture and Agri-Food Canada, Lennoxville, QC, Canada, ²Laval University, QC, Canada, ³cole Vtrinaire de Toulouse, France.

The aim of the present study was to determine the effects of dietary supplements of vitamins, on vitamin status, libido and semen characteristics in young boars under normal and intensive semen collection. Sixty boars were randomly allocated from 8 to 15 months of age to one of the following diets: (B, n=15) basal diet (commercial formulation for boars) for minerals and vitamins; (B+C, n=15) B diet supplemented with vitamin C (1 g daily); (B+F, n=15) B diet supplemented with fat-soluble vitamins (3 times for D and 5 times for A, E, K higher than B); (B+W, n=15) B diet supplemented with water-soluble vitamins (10 times higher than B). After puberty (10 months of age), semen was collected at a regular frequency (3 times every 2 weeks) during 2 months. Thereafter, all boars were intensively collected (daily during 2 weeks). A resting period of 10 weeks followed. Sperm quality and quantity were recorded as well as boar libido, on all animals. Blood and seminal plasma samples were taken during this experiment to monitor vitamin status. Semen production was higher during the intensive collection period, for boars supplemented in the B+W group (P≤.06) and B+F group (P≤.1). During the resting period, the percentage of motile sperm was higher in B+W boars (P≤.03) and, in a lesser extent, in B+F boars (P≤.1), as compared to control boars. Sperm morphology and libido were not affected by treatments (P≥.15). High concentrations of B6 (P≤.05) and folic acid (P≤.01) were observed in blood plasma of B+W boars while higher concentrations of vitamin E (P≤.01) were obtained in B+F boars. In seminal plasma, an increase in folic acid concentrations was noted in B+W boars (P≤.01). In conclusion, dietary supplements of water-soluble and fat-soluble vitamins appear to increase semen production in response to stress conditions such as an intensive semen collection.

The transfer of vitamins from the blood plasma into the seminal plasma seems rather limited.

Key Words: Boars, Vitamins, Semen

PSA Physiology: Reproduction and Endocrinology

1936 Laying hen response to molt induction by either pelleted alfalfa or alfalfa meal. K Medvedev*¹, C Woodward¹, X Li¹, L Berghman¹, L Kubena², D Nisbet², and S Ricke¹, ¹Texas A&M University, Department of Poultry Science, ²USDA-ARS, Food and Feed Safety Unit.

Molting is a process commonly utilized by commercial laying facilities to extend and improve the productivity of a flock. This practice usually involves the deprivation of feed for a period of several days in order to rejuvenate the reproductive system. Due to food safety and consumer awareness factors, alternatives to this approach are being investigated. Feeding alfalfa as an insoluble fiber source with the purpose of inducing molt is one such alternative. In this study, 118 hens were fed one of four diets: Layer Ration, Alfalfa Meal, Alfalfa Pellets, and Feed Deprivation. Hen weights were monitored 5 times during the trial to assess weight loss throughout the molting phase. During the trial, 8 hens per treatment were assessed for stress level using a tonic immobility technique. At the end of the trial, 58 hens from respective diet groups were sacrificed, and ovary weights were obtained to monitor regression of the reproductive system after a completed molting cycle. The diets correlated to the final hen weight with a p value ≤ 0.05 where feed deprivation birds lost 22.55%, alfalfa meal birds lost 16.85%, alfalfa pellet birds lost 13.03%, while birds kept on layer ration gained 2.31%. Ovary weights correlated to diet with a p value ≤ 0.05 where feed deprivation birds had a mean ovary weight of 6.37g, alfalfa meal birds had 5.08g, alfalfa pellet birds had 5.73g, and layer ration birds had 35.72g. No significant differences in stress response were noted in birds from these studies. Based on layer hen response, it appears that alfalfa can induce molt with the same efficiency as feed deprivation.

Key Words: Alfalfa, Hen Response, Molt

1937 Interleukin-1 β (IL-1 β) reduces the activity of 3 β -hydroxysteroid dehydrogenase (3 β -HSD) in granulosa cells of laying hens. M. A. Alodan*¹ and M. M. Beck¹, ¹University of Nebraska.

It is known that high environmental temperature (heat stress, HS) significantly reduces egg production, in part at least through disruption of reproductive hormones, progesterone (P₄), luteinizing hormone (LH), and estrogen (E₂). There are many well documented systemic effects of HS that may affect these hormones, but very little is known about local mechanisms through which HS acts. Interleukin-1 is increased by stress, including HS, and recently, in mammals, it has been shown that cytokines interleukin-1 α and IL-1 β play a role in ovarian function. The role(s) of cytokines in the bird remain unclear. The aim of this study was to determine the effect of HS and IL-1 β on the activity of 3 β -HSD, one of the major enzymes involved in steroidogenesis, in the granulosa cells (GC) of the laying hen. Two groups of hens were used in this study; one group was subjected to 24C, 30%RH (control), the other group to 36C, 60%RH (HS treatment). At the end of HS, the F1 follicles were collected from both groups and the GC dispersed enzymatically. The GC preparation from the control group was divided into three aliquots. One served as a control for the HS treatment; the other two were incubated with 100ng/ml IL-1 β or without IL-1 β (IL control) for 5h at 39C. Approximately 10,000 viable GC from each treatment were incubated in 1.5 ml of medium (PBS, pregnenolone, NAD, and nitroblue tetrazolium, pH 7.4) using 24-well flat-bottom plates at 39C for 90 min. After the incubation period, wells were examined with inverted microscope for dark blue formazan precipitate. A total of at least 100 cells per sample were examined to determine the percentage of cells that stained positive for 3 β -HSD (dark blue cells). Both HS and IL-1 β significantly reduced the percentage of 3 β -HSD positive cells ($P=0.000$, 0.053 , respectively). We hypothesize that HS reduces the activity of 3 β -HSD in the granulosa, and that reduction may be in part, at least, mediated through IL-1 β .

Key Words: Heat stress, Progesterone, 3 β -HSD

1938 Expression of the activin type II receptors and the inhibin/activin subunits during follicular development in broiler breeder hens. A. J. Davis* and S. N. Slaphey, University of Georgia.

There are two known activin type II receptors (ActRII and ActRIIB). An activin type II receptor must bind with an activin type I receptor to form a complex that can bind activin and then elicit downstream signaling by phosphorylation of proteins. The expression of mRNA for ActRII, ActRIIB, follistatin and inhibin/activin subunits was investigated in the follicles of broiler breeder hens. Total RNA was isolated from individual granulosa and theca layers of the F₁ through F₅ follicles, a pool of the F₆-F₇ follicles, the small yellow follicles (5-12 mm) and from the combined granulosa and theca layers of the large white follicles (2-5 mm) from 6 birds. 40 μ g of total RNA per sample was run on a 1.5% agarose/formaldehyde gel and then transferred to nylon membrane for Northern analysis with chicken cDNA probes for the activin type II receptors, follistatin, the inhibin/activin subunits and GAPDH (control). Two ActRII mRNA transcripts of 6.5 and 3.7 kb were detected in all of the theca and granulosa samples. Both transcripts were equally expressed in granulosa samples, but in theca samples expression of the 3.7 kb transcript was significantly greater than the 6.5 kb transcript. ActRIIB was not detected by Northern analysis in any of the samples. Expression of the mRNA for the activin/inhibin binding protein, follistatin was detected in both theca and granulosa samples with the greatest expression found in small yellow follicle samples for both cell layers. Expression of the inhibin α -subunit was detected in the granulosa layer of all the follicles. Expression of the inhibin α -subunit was highest in the F₆-F₇ granulosa layer. Granulosa layers from large hierarchical follicles expressed the most inhibin/activin β -A-subunit, while expression of the inhibin/activin β -B-subunit was highest in nonhierarchical follicles. This is the first report, to our knowledge, of the detection of activin type II receptor mRNA in the hen ovary, and characterization of the expression pattern of the inhibin family in both the theca and granulosa layers throughout follicular development. The presence of activin receptor and follistatin mRNA in both the theca and granulosa layers of the small developing follicles suggests that locally produced activin might have a vital role in early follicular development.

Key Words: Activin receptors, Chicken

1939 Immunization of male broiler breeders against mammalian Gonadotropin Releasing Hormone. J.A. Vizcarra*¹, M.L. Rhoads¹, C.C. Hsu¹, J. Washington¹, J.L.M. Morgan¹, J. Yang¹, H. Tang¹, K. Shaffer¹, and J.D. Kirby¹, ¹Department of Poultry Science, University of Arkansas, Fayetteville, AR 72701.

Twenty broiler breeder males were used to evaluate the effect of immunization against mGnRH on the development of antibody titers, adult testis weight, pulsatile LH and FSH secretion, and expression of mRNA for FSH-beta in the pituitary and LH receptors in testis. A mGnRH-fimbriae antigen (Intervet International) was emulsified in Freund's incomplete adjuvant and DEAE. At 10 wk of age (WOA), males were randomly assigned to two treatments, and received a primary immunization against mGnRH (50 g), or were not immunized. Booster immunizations (total of 60 g) were given at 3, 6 and 14 wk after the primary immunization. Weekly plasma samples were obtained from 10 WOA until the end of the experiment to evaluate titers against mGnRH and concentrations of testosterone by RIA. At 28 WOA, a jugular cannula was inserted, and blood samples (1 ml) were collected at 10-min intervals for 8 h. Plasma was stored at -20 C and analyzed for LH and FSH concentrations. At the end of the 8 h acute sampling period, males were killed. Pituitaries were removed to evaluate the expression of mRNA for FSH-beta subunit, and testes were obtained to evaluate daily sperm production (DSP), and expression of mRNA for LH receptors. There was a remarkable variation in titers between birds immunized against mGnRH. Only 2 of 10 birds had titers greater than 50% after the second booster immunization, and 4 of 10 birds had titers greater than 20%. Titers of 4 of 10 birds were

slightly above control (7%). Testosterone concentrations were decreased only in birds with titers greater than 20%. Testis weights and expression of mRNA for FSH-beta were significantly reduced in immunized birds. Concentrations of LH, FSH, DSP, and expression of LH receptor mRNA were not affected by treatment. Despite a significant variation in the response to the p-fimbriae antigen, immunization against mGnRH decreased testis weight and FSH-beta expression in adult broiler breeder males.

Key Words: GnRH, LH and FSH, mRNA

1940 Thyroid hormone and prolactin profiles in male and female turkeys following photostimulation: Validation of an ELISA for turkey prolactin. J. A. Proudman^{*1}, T. D. Siopes², F. Vandesande³, and L. R. Berghman⁴, ¹*Germplasm & Gamete Physiology Lab, ARS, USDA, Beltsville, MD 20705*, ²*Department of Poultry Science, North Carolina State University, Raleigh, NC 27695*, ³*Lab of Neuroendocrinology and Immunological Biotechnology, Catholic University of Leuven, Belgium*, ⁴*Poultry Science Department, Texas A&M University, College Station, TX 77843*.

Reproduction in turkeys is controlled by photoperiod and is a balance between two physiological states, photosensitive and photorefractory (PR). The hen requires a period of short day lengths to establish photosensitivity while the tom does not. Further, the hen and tom are known to express the PR response differently. The PR response is thought to be programmed by the presence of thyroxine (T4) during the early wk following photostimulation (PS). The sex difference in PR response of turkeys is not known to exist in other species, and provides an opportunity to differentiate hormonal influences on programming of PR. Our objective was to compare the early, post-lighting hormone profiles in hens and toms of three hormones, T4, triiodothyronine (T3), and prolactin (PRL). In addition, PRL was measured by both radioimmunoassay and a new homologous sandwich ELISA technique that uses a monoclonal capture antibody and a polyclonal detection antibody, permitting measurement without use of radioactivity. Results showed no significant difference in T4 levels of hens and toms measured at weekly intervals for 8 wks following PS, and at 10, 12, 16, and 22 wks. The T3 levels of toms were lower than those of hens at PS, and subsequently increased, while T3 levels of hens declined. PRL levels increased markedly following PS in hens, but remained very low throughout reproduction in toms. A high correlation ($r=0.94$) was observed between RIA and ELISA measurements of PRL levels in hens, but absolute PRL values measured by ELISA were lower ($P<0.001$) than those measured by RIA. We conclude that there are post-lighting sex differences in hormone profiles for PRL and T3 but not T4.

Key Words: photorefractoriness, hormones, turkey

1941 Dietary Manipulation of Rooster Sperm. Denise C. Bongalhardo^{*1} and Mary M. Buhr¹, ¹*University of Guelph*.

Lipid composition of sperm has been related to sperm quality and it can be modified by dietary means. Two experiments were conducted to monitor sperm quality of birds fed diets with different lipid composition. In the first trial, 20 White Leghorn roosters were randomly allocated in one of four treatments: control diet, diet containing corn oil, fish oil or flax seed as lipid source. The birds were ejaculated at 35, 36, 37, 38, 45, 46, 47, and 50 weeks of age. From 35 to 37 and 48 to 50 weeks of age, all birds were fed the control diet. From 38 to 47 weeks, they were fed the experimental diets. Semen was collected twice a week by abdominal massage, and the semen of the second collection was analyzed for concentration (estimated by spectrophotometer), motility (subjective microscopic analysis), viability (SYBR-14/PI fluorescent staining), and volume. In the second trial, 64 White Leghorn roosters were randomly allocated in one of the 4 treatments previously described. In the first (20 and 21 weeks of age) and in the last two weeks (27 and 28 weeks of age) of experiment, all birds were fed the control diet. From 22 to 26 weeks, they were fed the experimental diets. The semen was evaluated by concentration (spectrophotometer), motility (computer-assisted analysis), viability (flow cytometer), and volume. Repeated measures design was used to analyze the normalized data. The effect of diet was not significant ($P>0.05$) for any trait analyzed in the older birds in the first trial. In the second trial, diets didn't change concentration, viability or motility values ($P>0.05$), but diets containing corn and fish oil increased ($P<0.0123$) the volume ejaculated (0.60 0.22 and 0.65 ml

0.22, respectively) vs. control or flaxseed diets (0.50 0.23 and 0.51 0.24 ml). Lipid composition of diets affects semen parameters.

Key Words: Sperm, Diet, Lipids

1942 Sperm mobility phenotype influences duration of fertility in turkeys after insemination at 0 or 24 hour *in vitro* storage of sperm. A. M. Donoghue¹, D. P. Froman², Y. K. Kirby^{*1}, D. J. Donoghue³, and J. D. Kirby³, ¹*PPPSR, ARS, USDA, Fayetteville, AR*, ²*Oregon State University, Corvallis, OR*, ³*University of Arkansas, Fayetteville, AR*.

Sperm motility phenotype is based upon the ability of sub-populations of sperm to penetrate a solution of Accudenz (a viscous, inert non-toxic medium) at body temperature from a sperm suspension overlay. Repeatedly, we have demonstrated that sperm mobility phenotype correlates with fertility and can be used to predict the reproductive fitness of toms or roosters. The objectives of this study were to: 1) determine if duration of fertility is different between toms of good or poor phenotype; 2) determine if mixing semen from good and poor phenotype toms influences duration of fertility; and 3) evaluate whether storing semen of high and low phenotype at 4C for 24 h influences fertility outcomes. Toms ($n=57$) were assessed for sperm mobility on 3 occasions and ranked. Toms with the highest mobility scores and lowest mobility scores were identified as Good or Poor, $n=6$ /group. Equal amounts of semen from each group was pooled for the Mixed group. Hens ($n=20$ /group) were inseminated 2 days apart with Good, Mixed or Poor semen within 1 h of collection (0 time) or after 24 h of *in vitro* storage at 4C. Duration of fertility was assessed for 50 days following the final insemination. Fertility was higher in the Good (57.84.3, 23.15.2) and Mixed (53.26.1, 25.14.3) groups compared to the Poor (42.86.6, 13.72.9) group at both 0 and 24 h storage times, respectively ($P<0.05$). Interestingly for all groups at the 0 time insemination and the Good group at 24 h, the level of fertility remained constant for 14 days before a daily decline in % fertile eggs was observed. However, the 24 h *in vitro* stored semen from the Mixed and Poor groups demonstrated an immediate decline in % fertility. These data suggests that sperm quality, as determined by mobility influences fertility possibly by altering the storage capability of sperm in the hen. Supported in part by the U.S. Poultry and Egg Association (#340).[®]

Key Words: Sperm, Poultry, Fertility

1943 Demonstration of ovoinhibitor, a serine-protease inhibiting protein, in the chicken brain. L.R. Berghman^{*1}, E. D'Hondt², R.W. Moore³, B.M. Hargis⁴, C.M. Oubre¹, and F. Vandesande², ¹*Texas A&M University, College Station TX*, ²*University of Leuven, Belgium*, ³*USDA-ARS, College Station TX*, ⁴*University of Arkansas, Fayetteville AR*.

As suggested by its name, ovoinhibitor is a protease inhibitor that was originally purified from egg whites about 50 years ago. It is a 56 kDa protein that specifically inhibits serine proteases such as trypsin and chymotrypsin. Anti-ovoinhibitor monoclonal antibodies (MABs) were unexpectedly obtained as a side-product during the production of MABS against purified chicken bursa of Fabricius protein preparations. This event led to the first demonstration of ovoinhibitor in an avian immune organ. More recently, further immunocytochemical research also revealed ovoinhibitor-immunoreactivity in subsets of chicken pituitary cells (see companion communication) and, as described in the present report, in the brain of the chicken. Seven- μ m paraffin sections of Bouin-Hollande sublimate fixed chicken brain tissue were used throughout this study. Upon standard dewaxing and rehydration, sections were incubated overnight with the MAB and detection was performed with a peroxidase-labeled secondary antibody combined with diaminobenzidine and hydrogen peroxide. Both in 18-day old embryos and in 4-week old chickens, immunopositive cells were observed surrounding the lateral ventricles, the pallial commissure and the third ventricle (i.e. paraventricularly). Interestingly, in the embryo labelled cells were also found in the cerebellum, surrounding the fourth ventricle. In line with the above observation of specifically stained cells in several circumventricular areas, cerebrospinal fluid (CSF)-contacting nerve endings were prominent around the lateral ventricles, especially in the embryo. It is tempting to speculate that ovoinhibitor may be secreted into the CSF where it could play a role in inhibiting proteolytic breakdown of regulatory peptides or proteins. Serine protease inhibitors from a different family have

recently been shown to be involved in neuronal plasticity and neuroprotective mechanisms. The precise function of ovinhibitor in the brain will be a topic for further research.

Key Words: chicken, ovinhibitor, brain

1944 Vasotocin receptor mRNA expression in the brain and pituitary of broiler breeder hens. K. Shaffer*¹, J.A. Vizcarra¹, C.C. Hsu¹, J.Y. Yang¹, M.L. Rhoads¹, L.E. Cornett², D. Baeyens³, N. Ali³, and J.D. Kirby¹, ¹Department of Poultry Science, University of Arkansas, Fayetteville, AR, ²Department of Physiology, University of Arkansas for Medical Sciences, ³Department of Biology, University of Arkansas Little Rock, Little Rock, AR.

Vasotocin receptors (VTR) are members of the seven trans-membrane spanning G-protein associated receptor superfamily. Several members of the vasopressin-oxytocin-mesotocin receptor family have been characterized in vertebrates. We have previously shown that VTR-1 expression occurs primarily in the brain while VTR-2 expression occurs mainly in the pituitary. Our goal was to evaluate the expression of VTR-1 and VTR-2 mRNA in known sites of expression over the ovulatory cycle of

hens. In order to study potential changes in VTR-1 and VTR-2 expression, birds (n=4-5 per time point) were killed at 3 hour intervals relative to oviposition over a 24 hour period. Blood samples were drawn within 2 minutes of handling, prior to cervical dislocation. Brain, pituitary, shell gland, and kidney were immediately removed and frozen in liquid nitrogen. Plasma was stored at -20 C prior to determination of corticosterone levels by RIA. Isolated total RNA from the brains and the pituitaries was transferred to nylon membranes for analysis of receptor steady state mRNA levels by slot blot analysis. Full length cDNAs for VTR-1, VTR-2 and 28-S rRNA were used to make random primed cDNA probes. VTR-1 and VTR-2 mRNA expression levels were normalized relative to 28-S expression for each sample. Corticosterone levels were significantly increased at nine hours post oviposition relative to all other times. Neither VTR-1 nor VTR-2 mRNA levels showed any significant variation over the 24 h cycle, in the brain or pituitary, respectively. Based on these results, we conclude that VTR-1 and VTR-2 steady state mRNA levels do not fluctuate dramatically over the ovulatory cycle of broiler breeder hens. Further work on circadian variations in membrane bound receptor concentrations in the brain and pituitary are currently underway.

Key Words: Vasotocin Receptor, Pituitary and Brain, Corticosterone

ASAS Nonruminant Nutrition: Feed Ingredients and Enzymes

1945 Effect of lactic acid and lactosucrose supplementation in diets for nursery pigs. Acie Murry*¹, Susan Sanchez¹, and Parshall Bush¹, ¹The University of Georgia, Athens.

Swine producers have been adding organic acids to feed for several years. Acidified feed lower the pH of the pig's stomach, inhibit certain pathogenic bacteria, increases nutrient digestibility and results in faster weight gain and more efficient feed conversion. Lactosucrose is considered a nondigestible trisaccharide produced from lactosucrose and sucrose and may be used as a substrate by intestinal bacteria in humans. The influence of these factors has not been documented in nursery pigs. The objective of this study was to evaluate the effects of lactic acid and lactosucrose supplementation in pig's diet on growth performance, feed efficiency and nutrient digestibility. Two experiments with twenty cross bred nursery pigs, average initial body weight 9.6 kg and age 28 days were conducted. All pigs were fed a corn-soybean meal basal diet (18% CP) for a 7-d adjustment period. On day seven after the adjustment period, ten pigs were randomly assigned to receive the basal diet supplemented with either lactic acid (1.8%) or lactosucrose (0.2%) for a 14-d experimental period. Daily feed intake was held constant at 5% of body weight for all pigs in an attempt to reduce the effects of different levels of feed intake on nutrient digestibility. Pigs were weighed every three days and feeding was adjusted according to the pig's individual weight. Pigs fed the lactosucrose diet were heavier (P < 0.04) at d 21 (15.40 vs 14.95 kg), but there was no effect of treatment (P > 0.50) on average daily gain (0.45 vs 0.43 kg), average daily feed (0.57 vs 0.56 kg), or gain:feed ratio (0.80 vs 0.78 kg) for lactosucrose and lactic acid, respectively. Treatment had no effect (P > 0.20) on apparent digestibility of DM (80.96 vs 82.46%), EE (77.45 vs 79.50%), CP (72.30 vs 74.45%), or GE (69.69 vs 69.33%) for lactosucrose and lactic acid, respectively. However, ash digestibility was greater (P < 0.05) for pigs fed the lactic acid diet than for those fed lactosucrose (50.43 vs 43.15%). The results from this study show that growth performance was better in pigs fed the lactosucrose diet, but ash digestibility was lower when compared with pigs fed the lactic acid.

Key Words: Lactosucrose, Lactic Acid, Digestibility, Pigs

1946 The potential for egg by-products to replace spray-dried porcine plasma in early-weaned piglet diets. L.D. Schmidt*, C.M. Nyachoti, D. Boros, and B.A. Slominski, University of Manitoba Winnipeg, MB, Canada.

Egg-breaking facilities produce substantial quantities of egg by-products each year that are unsuitable for human consumption. Due to the excellent amino acid profile, the potential for spray-dried egg proteins to replace spray-dried porcine plasma (SDPP) in early-weaned pig diets was investigated in two 3-week performance trials. In both experiments, 5 pens containing four piglets (17 ± 1d old) stratified by sex were assigned to the experimental diets in a completely randomized design. Experiment 1 comprised of four corn-soy diets containing 7% of either SDPP,

spray-dried technical albumen (SDTA), heat treated SDTA (hot room storage at 70°C for 72h) or spray-dried whole egg (SDWE). Average daily gain (ADG), average daily feed intake (ADFI) and feed conversion ratios (FCR) were determined. In addition, five piglets per treatment were euthanized to determine ileal amino acid and energy digestibilities. Relative to the SDPP diet, ADG (266, 219, 199, 194 g/d), ADFI (323, 304, 277, 278 g/d) and FCR (1.22, 1.38, 1.46, 1.44) were poorer (P<0.05) for SDTA, heat treated SDTA and SDWE, respectively. The SDTA diet had numerically better performance parameters than the other diets containing egg proteins. Apparent ileal digestibility of methionine, lysine and threonine in SDPP and SDTA diets ranged from 80-90% and was generally higher (P<0.05) than in the SDWE diet. Ileal digestible energy content was similar (P<0.05) in all diets (3.1-3.2 Mcal/kg). In the second experiment, the effect of substituting SDPP with 25 or 50% SDTA was investigated. Pig performance was not affected by dietary substitution of SDTA for SDPP as values for control (7% SDPP) and the two SDTA diets were similar (P<0.05) for ADFI (380, 402, 376 g/d), ADG (275, 284, 265 g/d) and FCR (1.38, 1.42, 1.45), respectively. The results suggest that technical albumen can replace 25% of SDPP in early-weaned pig diets without compromising performance.

Key Words: Egg by-products, Nutritive Value, Early-weaned pigs

1947 Comparison of edible grade whey, granular whey, and Dairylac 800 as lactose sources for nursery pig diets. J.M. DeRouchey*, M.D. Tokach, J.L. Nelssen, R.D. Goodband, S.S. Dritz, J.C. Woodworth, and B.W. James, Kansas State University, Manhattan, KS.

A total of 210 pigs (BW of 5.6 kg and 18 d of age) were used in a 14-d growth assay to determine the ability of granular whey or Dairylac 80[®] to replace a high quality, edible grade whey in nursery diets. Pigs were blocked by weight and allotted to one of seven dietary treatments. Treatments included a negative control without lactose and a 2 x 3 factorial consisting of two lactose levels (9 and 18%) and three lactose sources (Edible whey, Land O' Lakes; Granular whey, International Ingredient Corp.; and Dairylac 80[®], International Ingredient Corp.). There were five pigs/pen and six pens/treatment. All diets were pelleted and contained 3% animal plasma and 2% select menhaden fish meal and were formulated to 1.60% lysine. Either edible whey or granular whey (12.5 and 25%) replaced corn and soybean meal in the control diet. Diets containing Dairylac 80[®] were formulated to replace the lactose provided in the dried whey diets. Fish meal replaced the amino acids provided by dried whey to maintain a constant soybean meal level. Pigs fed additional lactose from d 0 to 14 had greater ADG (P<.04) and ADFI (P<.07) compared to pigs fed no supplemental lactose. Pigs fed edible whey had greater ADFI (quadratic, P<.05) and ADG (linear, P<.06) with increasing lactose from 9 to 18%. As granular whey level increased, ADG and ADFI increased (linear, P<.02) over the control diet from d

0 to 7, but not overall. For pigs fed DairyLac 80[®], ADG and ADFI were greater (quadratic, $P < .01$) compared to pigs fed the negative control, while gain/feed improved (linear, $P < .02$) as the lactose level was increased from 9 to 18%. Pigs fed 9% granular whey and DairyLac 80[®] had similar performance to pigs fed 18% edible whey. In conclusion, there were no differences in growth performance between sources of lactose used in this study.

Item	Control		Edible		Granular		DairyLac 80 [®]		SEM
	Lactose, %	0	9	18	9	18	9	18	
Day 0 to 14									
ADG, g	238	243	283	263	257	291	265	11	
ADFI, g	248	242	294	261	270	296	256	13	
G/F, g/kg	960	1000	963	1001	952	983	1004	24	

Key Words: Pig, Lactose, Growth

1948 Productive performance and carcass characteristics of growing and finishing pigs fed different level of oat groats with and without enzymatic compound. F. Salvador, C. Rodriguez*, F. Nunez, J. Jimenez, O. Ruiz, and A. Alarcon, *Universidad Autonoma de Chihuahua, Chihuahua, Chih. Mexico.*

An experiment was carried out to determine the optimum level of oat groats and the effect of the addition of the enzymatic compound Allzyme Vegpro[®] in growing and finishing pig rations on the productive response and carcass characteristics. Thirty two Yorkshire X Landrace-Duroc pigs distributed in individual metabolic cages with a completely randomized design of a 4x2x2 factorial arrangement were used. Pigs were fed a ration containing 0, 15, 30 and 45% oat groats during the growing (26.0 to 54.5 kg of BW) and finishing period (54.5 to 84.7 kg of BW), with and without one kg Allzyme Vegpro[®] per ton of feed. A tendency to improve ($P < .01$) feed conversion during the whole feeding period by including oat groats in the ration (3.73, 3.46, 3.32 and 3.17 for 0, 15, 30 and 45% oat groats in the ration, respectively) was observed, with a reduction up to 17.9% with the highest oat groats level in the diet. Males showed higher feed intake (9.1%) and daily weight gain (6.3%) than females. Multivariate analysis showed a true effect during the last phase of the finishing period, with a decrease in pig feed intake of up to 250 g/d and an extra daily weight gain of 21 g per pig in animals fed 45% oat groats plus enzymatic compound rations. A tendency to improve cold carcass yield was detected as the ration oat groat level increased but only when the enzyme was added. Males showed 4 mm higher dorsal fat than females. Those animals eating diets with the enzymatic compound showed 3 mm higher dorsal fat than those without enzyme. With higher levels of oat groats in the ration there was a tendency to decrease ($P < .05$) the fat content in muscle. It was concluded that the addition of oat groats to diet of growing and finishing pigs improves the animal productive response showing an increase of up to 9.5% in economic return for every 15% addition of oat groats.

Key Words: Pigs, Oat groats, Enzymes

1949 The effects of pretreating soybean meal with fiber-degrading enzymes on ileal and total tract digestibility by growing pigs. K. L. Saddoris*, M. R. Smiricky, D. M. Albin, V. M. Gabert, and M. R. Murphy, *University of Illinois, Urbana.*

Soybean meal (SBM) contains fibrous components that are poorly digested by pigs. Pigs do not produce the endogenous enzymes necessary to digest the fibrous components of SBM, so fiber-degrading enzymes such as arabinase, cellulase, alpha-galactosidase, hemicellulase, pectinase, and xylanase can be used in an attempt to degrade these components. Four barrows (avg. BW = 75 kg) were surgically fitted with a prececal simple-T cannula and randomly assigned to a 2 x 2 crossover design to evaluate the influence of pretreating SBM with fiber-degrading enzymes on nutrient digestibility. The cornstarch-soybean meal-based diets were formulated to contain 17% CP. Chromic oxide (0.3%) was added as an indigestible marker for determination of nutrient digestibilities. A control cornstarch-soybean meal diet was compared to a diet containing SBM pretreated with enzymes. The pretreatment consisted of dilution with deionized, distilled water at a 1:4 ratio and incubation at 50C, pH 5 for 18 hr with 8.5 g each of the following enzymes/kg of SBM: arabinase, cellulase, alpha-galactosidase, hemicellulase, pectinase,

and xylanase. Pigs were fed 2.28 and 2.44 kg/d for periods 1 and 2, respectively, in 2 equal feedings at 0800 and 2000 h. The experimental period lasted 7 d, with 5 d of diet adaptation, fecal collection on d 6, and ileal digesta collection on d 7. Diets, feces, and digesta samples were analyzed for DM, OM, CP, AA, and chromic oxide concentrations. Enzyme pretreatment increased ($P < 0.08$) ileal digestibility of DM, OM, Asp, Glu, Lys, and total tract digestibility of OM, N, Asp, Thr, Ser, Gly, Val, Phe, His, Lys, Ile, and Tyr. Enzyme pretreatment tended ($P < 0.15$) to increase ileal digestibility of Pro, Val, Ile, Leu, and total tract digestibility of DM, Glu, Pro, and Leu. In conclusion, enzyme pretreatment of SBM increased DM and AA digestibilities of cornstarch-soybean meal diets fed to growing pigs.

Key Words: Pigs, Enzymes, Soybean meal

1950 Evaluation of a carbohydrase combination on performance in growing-finishing pigs. M. D. Lindemann¹, G. A. Apgar², T. Guthrie*², G. L. Cromwell¹, H. J. Monegue¹, K. E. Griswold², and N. Inocencio¹, ¹University of Kentucky, Lexington, ²Southern Illinois University, Carbondale.

Arabinoxylans increase digesta viscosity and decrease digestibility. A bacterial enzyme product which contained endo-1,4- β -xylanase and β -glucanase (105 and 50 IU/g) was used to evaluate its potential for improvement of performance of growing-finishing pigs fed a fortified corn-soy diet (which typically contains 4-5% arabinoxylans). A total of 192 pigs were used in two experiments (Exp. 1: SIU, n=112 crossbred pigs, 45.6 kg BW; Exp. 2: UK, n=80 crossbred pigs, 34.7 kg BW) to evaluate graded levels of the product (0, 80, 100, and 120 mg/kg) on growth performance and carcass characteristics to a market weight of 112.8 kg. Pigs were housed seven/pen at SIU for a total of four replicates and four/pen at UK for a total of five replicates. The diet was formulated to 0.86% lysine; lysine levels were reduced to 0.68% and 0.55% at 58 and 82 kg, respectively. Diets were fed in meal form. All pigs were scanned by real-time ultrasound at 110 kg. There were no experiment x diet interactions for any criteria ($P = .20$). Performance for the initial grower period was improved (linear, $P < .02$) for ADG (940, 982, 962, and 1,022 g) but not ($P = .10$) for ADFI (2.24, 2.26, 2.31, and 2.31 kg) or F/G (2.37, 2.30, 2.39, and 2.26). For the total study, ADG (856, 896, 866, and 875 g), ADFI (2.67, 2.77, 2.74, 2.74 kg), and F/G (3.12, 3.10, 3.16, and 3.13) did not differ ($P = .10$) due to enzyme inclusion. Carcass characteristics (adjusted to 104 kg) did not differ ($P = .10$) with regard to backfat depth (20.8, 21.8, 21.1, and 20.8 mm), longissimus area (39.7, 40.6, 40.6, and 40.2 cm²), or scanned lean (52.4, 51.8, 52.4, and 52.5%). Lean gain (352, 360, 356, and 359 g/d) did not differ ($P = .10$) among dietary treatments. The greatest potential for a product directed at arabinoxylans would appear to be in the earlier stages of the grow-finish period.

Key Words: Pigs, Performance, Enzymes

1951 Amino acids ileal digestibility of hullless barley, barley and sorghum grains in growing pigs. G. Mariscal-Landin*¹ and J. E. Rodriguez², ¹C. N. I. Fisiologia y Mejoramiento Animal, INIFAP, ²Nutrientes Basicos de Monterrey, S.A. de C.V. NL, Mexico.

Nutritive value of grain sorghum, barley and hullless barley was assessed in 2 experiments. In Exp. 1, 4 barrows of initial BW of 40 kg were fitted with simple T cannulae at the terminal ileum. In a 4x4 Latin square arrangement, pigs were fed 4 diets formulated to 16% CP: corn-starch+soybean meal (SBM); sorghum+SBM (SSB); hullless barley+SBM (HBS) and barley+SBM (BAS). Amino acids apparent digestibility was measured using the difference method. A 6-d adaptation period was followed by a 48-h phase, sampling digesta in 2-h intervals. Pigs were fed in 2 meals (0800 and 1700 h) at 2.5x their DE maintenance requirement (110 Kcal of DE/kg^{.75}). Lys apparent digestibility was greater ($P < .05$) for SBM, 86.3 > SSB, 51.6 = HBS, 49.7 and BAS, 55%. Similar differences were found for Thr, SBM, 80.2 > SSB, 55.5 = HBS, 55.5 and BAS, 54.8%; Met, SBM, 87.9 > SSB, 64.6 = HBS, 70.0 and BAS, 66.9% and for most of the amino acids. Experiment 2 was a growth performance trial, in which sorghum grain was substituted by hullless barley at 0, 34, 66 and 100% of the total cereal grains in the diet (*i.e.*, 4 experimental diets). Initial weight of the pigs was 39.3 \pm 4.8 kg and the observation period was of 77-d. Barrows ate more ($P < .001$) than gilts: 2.57 vs 2.31 kg/d. Avg. of daily gain was similar ($P > .05$), a mean response of .751 kg, but gain:feed ratio was progressively improved

as hullless barley substituted sorghum: .293, .299, .316 and .328 kg. Differences in gain:feed between sexes were a direct response to feed intake. Lean eye area resulted in an diet x sex interaction ($P < .05$): barrows fed the higher concentration of sorghum (0 and 34% hullless barley) showed the lowest values: 20 and 23 cm², while the rest had a mean value of 28 cm². Considering apparent amino acid digestibility, sorghum and hullless barley are of similar nutritive value, but performance in response to hullless barley could be explained in terms of the better amino acid profile and the ME value.

Key Words: Sorghum grain, Barley grains, Amino acids digestibility

1952 Effects of Fibrozyme[®] supplementation on ileal and total tract digestion of nitrogen and energy by finishing pigs fed diets containing a fibrous soy co-product. M. R. Smiricky^{*1}, D. M. Albin¹, V. M. Gabert¹, H. Yang², and R. Dvorak³, ¹University of Illinois, Urbana, IL, ²ADM Feed Products Group, Quincy, IL, ³Alltech, Inc., Nicholasville, KY.

Fibrous components in swine diets are incompletely digested and are poorly utilized energy sources. Pigs do not produce the enzymes necessary to hydrolytically digest fibrous components of the diet. Fiber-degrading enzymes, such as Fibrozyme[®], have been used in an attempt to degrade these components. Four barrows (avg. initial BW = 85 kg) were surgically fitted with a prececal simple T-cannula and randomly assigned to a 2x2 crossover design to evaluate the influence of Fibrozyme[®] on nutrient digestibility. The corn-soybean meal-based diets were formulated to contain 12.5% CP, and a fibrous soy co-product containing 27% NDF (as-fed basis), was included at a level of 10% to test the effectiveness of the enzyme source. Chromic oxide was added as an indigestible marker for determination of nutrient digestibilities. The 2 treatments were a control diet and a diet containing 0.022% Fibrozyme[®] (as-fed basis), an enzyme supplement containing a minimum of 100 xylanase units/g, added at the expense of corn. The pigs were fed twice daily (0800 and 2000 h, 1.5 kg/meal). The experimental period lasted 7 d, with 5 d diet adaptation, fecal collection on d 6, and ileal digesta collection on d 7. Diets, feces, and digesta samples were analyzed for DM, OM, CP, GE, and chromic oxide concentrations. Dietary treatment did not significantly affect apparent ileal or total tract digestibilities of any of the parameters measured. However, there was a numerical increase in apparent ileal and total tract digestibilities when Fibrozyme[®] was added to the control diet. The increase in digestibility ranged from approximately 0.3 to 5 percentage units. In conclusion, Fibrozyme[®] numerically improved apparent ileal digestibilities of DM, OM, N, and GE of pigs fed a corn-soybean meal diet containing a fibrous soybean co-product.

Key Words: Pigs, Enzymes, Digestibility

1953 Effects of dietary supplementation of crude inulin extract on the emission of volatile sulfides from manure slurry of growing-finishing pigs fed corn and soybean meal-based diets. T.C. Rideout¹, M.Z. Fan¹, Y. Gao¹, C. Wagner-Riddle¹, J.P. Cant¹, P. Stonehouse¹, G. Sheffrin², R. Cook², B. Raines², and R.R. Hacker¹, ¹University of Guelph, ²Qtf Foods, Inc..

A balanced two-period changeover experiment was conducted with 6 Yorkshire barrows, average initial BW of 30 kg, to determine the effect of crude inulin, extracted from Ontario grown chicory, on the emission of volatile sulfides from swine manure slurry. Two corn and soybean meal (SBM)-based dietary treatments, a control diet containing no inulin extract and a treatment diet containing 5% crude inulin at the expense of cornstarch, were formulated to contain 16% CP from corn (51%) and SBM (29%). Each period lasted for 14d with 10-d adaptation and 4-d collection of total urine and representative fecal samples. At the end of each period, fresh manure slurry was prepared by mixing the collected feces and urine at a ratio of 1:2.5 (wt/wt). Accumulative sulfide emission was measured over a 7-d period in an in vitro system that trapped the emitted sulfide gas in a cadmium sulfate-based solution. Samples of the trapping solution were taken at specified time points (0, 4, 19, 24, 48, 96, 144, 168 h, respectively) over the 7-d emission period at room temperature. The amount of total sulfides trapped in the solution was determined in hydrogen sulfide unit through a spectrophotometric-based procedure. Inclusion of the inulin at 5% reduced ($P < 0.01$) the 168-h cumulative hydrogen sulfide emission rate by 36.4% in comparison with the control (14.96 vs. 22.69 mg H₂S/kg DM slurry/h). In conclusion, dietary supplementation of the crude inulin extract at a 5% dietary level

is effective in reducing the emission of odour-causing volatile sulfides into the environment.

Key Words: Inulin, Sulfide emission, Growing-finishing pigs

1954 Efficacy of mannan oligosaccharide (Bio-Mos[®]) addition with two levels of copper sulfate in the diets of growing-finishing pigs. M. E. Davis^{*1}, C. V. Maxwell¹, B. Z. de Rodas², D. C. Brown¹, Z. B. Johnson¹, and R. A. Dvorak³, ¹University of Arkansas, Fayetteville, ²Land O'Lakes Inc., Fort Dodge, IA, ³Alltech, Nicholasville, KY.

An experiment involving 144 crossbred barrows and gilts was conducted to determine the efficacy of Bio-Mos[®] in improving performance of growing-finishing pigs fed diets devoid of antibiotics and with and without growth promoting levels of CuSO₄. Pigs were moved from a nursery facility, sorted by BW and divided into six weight groups with 24 pigs in each group. Pigs within each group were allotted into four pens (6 pigs/pen) and stratified based on sex and litter. Treatments were randomly assigned to pens within each weight group (6 pens/treatment). Dietary treatments were fed throughout the starter (20 to 32 kg BW), grower (32 to 68 kg BW), and finisher (68 to 106 kg BW) phases. Diets consisted of two levels of CuSO₄ (10 ppm in starter, grower, and finisher diets vs. 175 ppm in starter and grower diets and 125 ppm in finisher diets) with and without Bio-Mos[®] (0 vs. 0.2% in starter, 0.1% in grower, and 0.05% in finisher). Average daily gain and gain:feed (G/F) improved ($P < 0.02$) in the starter phase when pigs were fed diets containing 175 ppm CuSO₄ compared to pigs fed 10 ppm CuSO₄. Gain:feed was greater ($P < 0.02$) in the grower phase when pigs were fed 175 ppm CuSO₄ compared to pigs fed 10 ppm CuSO₄. During the finisher phase, ADG improved with the addition of Bio-Mos[®] when pigs were fed 10 ppm CuSO₄, but decreased when Bio-Mos[®] was supplemented in diets containing 175 ppm CuSO₄ (interaction, $P < 0.04$). In the overall experiment (20 to 106 kg BW), ADG and G/F improved ($P < 0.03$) when pigs were fed diets supplemented with 175 ppm CuSO₄ when compared to pigs fed diets containing 10 ppm CuSO₄. The results of this experiment indicate that CuSO₄ supplemented in growing-finishing diets improves gain and efficiency. Additionally, Bio-Mos[®] improves gain when supplemented in growing-finishing diets without antibiotic addition, although the magnitude of response is not as great as that observed with CuSO₄ addition.

Key Words: Swine, Mannan oligosaccharide, Copper

1955 Dietary fiber level and xylanase affects nutrient digestibility and waste production in grower pigs. A.J. Moeser^{*} and T.A.T.G. van Kempen, North Carolina State University.

An experiment was conducted with twelve grower pigs to determine if lowering dietary NDF, through selection of available feedstuffs or dietary addition of xylanase, can provide an effective and practical approach for reducing nutrient excretion in pigs. Four diets were formulated, using least cost ration principles, to contain equal digestible lysine to ME ratios and three levels of dietary NDF: 1) control corn soybean meal diet (10.3% NDF), 2) low NDF diet (2.6% NDF) based on degermed, dehulled corn (79%), corn gluten meal (11.5%), meat and bone meal (5%), and blood meal (2.5%), 3) high NDF diet (18.4% NDF) based on corn and soybean meal with 20% soybean hulls, and 4) diet 3 + 0.2% xylanase. Diets were tested in a balance experiment using a 4X4 Latin square design in which each experimental period consisted of a 4-d dietary adaptation period followed by a 3-d data collection period. Lowering dietary NDF increased the digestibility of DM and GE (by 5 and 4%, respectively) but did not affect the digestibility of nitrogen (N) compared to the control diet ($P < 0.01$). Increasing dietary NDF reduced the digestibility of DM by 8%, GE by 8%, and N by 13% compared to the control ($P < 0.01$). Addition of xylanase improved the digestibility of DM and GE by 2 and 3%, respectively ($P < 0.01$) while a trend for improved digestibility of N was observed. Lowering dietary NDF reduced fecal production by 35% compared to the control ($P < 0.01$). Increasing dietary NDF increased fecal production by 36% compared to the control ($P < 0.01$). Addition of xylanase reduced fecal production by 10% in high NDF diets ($P < 0.01$). In conclusion, lowering dietary NDF level and dietary inclusion of xylanase may offer relatively practical and easy methods for reducing waste production in pigs.

Diet	Control	Low NDF	High NDF	High NDF + xylanase	SE
Digestibility, %					
Dry matter	88.2 ^b	92.3 ^a	81.6 ^d	83.5 ^c	0.63
Gross energy	87.6 ^b	91.3 ^a	80.4 ^d	82.5 ^c	0.65
Nitrogen	86.6 ^a	85.6 ^a	75.4 ^b	77.5 ^b	0.95
Fecal production, % of DMI	11.8 ^c	7.7 ^d	18.4 ^a	16.5 ^b	0.63

Values lacking common superscript differ (P < 0.01)

Key Words: Fiber, Digestibility, Grower Pigs

1956 Wheat specific weight or added enzyme did not affect weaner performance. H.M. Miller¹, P. Toplis², and P. Blanchard³, ¹University of Leeds, School of Biology, Leeds, LS2 9JT, ²Primary Diets Ltd., Melmerby, HG4 5HP, UK, ³Frank Wright Ltd., Ashbourne, DE6 1HA, UK.

Livestock industries in many countries use specific weight to indicate nutritive value of grain. The aim of this experiment was to compare 2 specific weights of Riband wheat (64 vs 78 kg/hl) when fed to weaned piglets with or without xylanase enzyme. To amplify possible differences wheats were uncooked and included in the test diets at an atypically high level. We hypothesised that 78 kg/hl specific weight would outperform 64kg/hl specific weight and that enzyme supplementation would improve performance of both wheats. One hundred and twenty eight 21 0.2d old piglets (62.5% Large White, 25% Landrace, 12.5% Duroc) were weaned at 6.3 0.2 kg liveweight into fully slatted flat deck pens. Piglets received no creep feed pre-weaning. Eight piglets were allocated to each pen (1.37 m x 1.43 m) on the basis of litter, liveweight and sex. The experiment was a 2 x 2 factorial design with Riband fed at 2 specific weights, 64 and 78 kg/hl, with or without enzyme. Four pens were randomly allocated to each of the 4 treatments. All diets contained ZnO (Zn 2500 ppm) and were formulated to contain 50% wheat, 16.25 MJ DE/kg, 1.63% total lysine. Enzyme was added to provide 5,500 xylanase units/kg feed and 600 β -glucanase units/kg feed. Piglets were individually weighed at 0, 7, 14 and 20d post-weaning. Food and water were provided ad libitum throughout the 20d trial. Data were analysed using the GLM procedure of Minitab 12.2. Growth rate (282 11 g/d), feed intake (291 10 g/d) and feed conversion ratio (1.04 .02) were similar for all treatments throughout the trial. End weight after 20d was not different between treatments (11.9 .24 kg). The low bushel weight wheat did not reduce piglet performance, neither did enzyme inclusion improve it. Despite the high inclusion of wheat, piglet performance was typical for the experimental unit. Use of specific weight as an indicator of nutritive value is questioned.

Key Words: Specific weight, Piglets, Wheat

1957 Efficacy of Allzyme Vegpro in swine diets. L. J. Johnston¹, H. G. Jung², J. A. Wilson¹, and J. E. Pettigrew³, ¹University of Minnesota, Morris, ²USDA-ARS, St. Paul, ³Pettigrew Consulting International, Louisiana, MO.

A growth performance (Exp. 1) and a digestibility (Exp. 2) experiment were conducted to determine the efficacy of an enzyme preparation, Allzyme Vegpro[®], in diets for nursery pigs containing soybean meal (SM; 44% CP) or dehulled SM (DSM; 47% CP). Vegpro contains protease, cellulase, pentosanase, α -galactosidase, and amylase activity. Pigs (n = 200) were weaned at about 19 d of age for Exp. 1. After consuming a common phase 1 diet for 12 d, pigs were blocked by weight and allotted to 20 pens. Pens were assigned randomly within block to one of four diets in a 2 x 2 factorial arrangement of treatments. Main effects were inclusion of Vegpro (-V or +V) and type of SM. Vegpro was included in phase 2 and 3 diets at .14 and .17%, respectively. Pigs had ad libitum access to phase 2 (1.2% lysine) and 3 (1.1% lysine) diets that were marginal in lysine concentration for 2 and 3 wk, respectively. Pigs fed DSM grew faster (P < .05) than those fed SM regardless of Vegpro inclusion (.529 vs .475 kg/d; SE = .019). An interaction (P < .01) between Vegpro addition and SM type was observed for feed efficiency (1.724, 1.774, 1.692, 1.608 for -V/SM, +V/SM, -V/DSM, and +V/DSM, respectively). In Exp. 2, barrows (n = 20) were weaned at about 18 d and housed individually in stainless steel cages. Pigs received a common phase 1 diet for 14 d then were assigned randomly within litter to the same phase 2 diets as used in Exp. 1. A 7-d adjustment period preceded a 5-d total collection period to determine energy and nitrogen balance.

Nitrogen retention (91.23, 92.04, 89.47, 91.81%; SE = .014) and ME (91.52, 91.44, 90.58, 90.96% of GE; SE = .71) were not influenced by diet. Addition of Vegpro tended to reduce (P < .10) digestibility of total dietary fiber polysaccharide (72.6, 66.9, 70.5, 65.8%; SE = 2.72). Addition of Allzyme Vegpro to corn-soybean meal based diets did not improve growth performance of nursery pigs or digestibility of dietary energy or nitrogen.

Key Words: Swine, Enzymes, Digestibility

1958 Beneficial effect of using a blend of flavoring substances in promoting appetite and growth performance in weaned piglets. A. Piva¹, M. Morlacchini², F. Galvano³, and A. Prandini⁴, ¹University of Bologna, Ozzano Emilia, Italy, ²CERZOO, Piacenza, Italy, ³University of Reggio Calabria, Reggio Calabria, Italy, ⁴Universita' Cattolica del S. Cuore, Piacenza, Italy.

The ban on the use of certain antibiotic feed supplements instituted or planned in several countries has renewed the interest in exploring alternatives to the use of antibiotic growth promoters. The aim of the present study was to investigate a blend of natural and natural identical flavoring substances in promoting appetite and growth performance in weaned piglets. The trial was conducted using 40 weaned piglets (9.31.60 kg BW) divided in 2 homogenous groups and fed the experimental diets for 56 days. The control group received a conventional diet containing 500 g/ton of formic acid and 1500g/ton of lactic acid (CTR diet); the experimental group was fed the CTR diet containing 2 kg/ton of HerBioticTM HB (HB diet). Feed intake was recorded and pigs were individually weighed at 14, 35, and 56 d after the study commenced. Differences between the dietary treatments were already observed after 14 days of the trial in terms of average daily gain (ADG: 218 vs 268 g/d for CTR and HB, respectively; +22.9%; P<0.05) and live weight (12.4 vs 13.1 kg; P<0.05). During the study, ADG was improved by HB (378 vs 439 g/d; +16.1%; P<0.01) with a noticeable increase in ADG in the period 36-56 d (440 vs 525 g/d for CTR and HB, respectively +19.3%; P<0.05). The feed intake was higher in HB than in CTR fed animals in the periods 0-14 and 0-35 days by 20.7% (P<0.01) and by 12% (P<0.01), respectively, with no statistical difference thereafter. The feed efficiency was higher only in the period 36-56 days of the trial in HB fed animals (1.68 vs 1.91 kg feed/kg weight gain; P<0.05). Overall there was a substantial decrease in time to reach 30 kg l.w. (-8 days) in animals fed the HB diet. In conclusion, compared to the control group fed an acidified diet animals fed HerBioticTM HB displayed improved feed intake and growth performance.

Key Words: Additive, Botanical, Pig

1959 Effect of plant extracts on the performance and lower gut microflora of early weaned piglets. E.G. Manzanilla¹, F. Baucells¹, C. Kamel², J. Morales¹, J.F. Perez¹, and J. Gasa¹, ¹Universidad Autonoma de Barcelona, ²AXISS France, S.A.S. Archamps, France.

Two hundred and forty early (20±2.0 d) weaned piglets (5.4±0.4 kg LW) were randomly distributed in 24 replicates to carry out a 3x2 experimental design. Three diets were formulated with the same proportion of cereals (42%), milk by-products (25%), and porcine plasma (4%) but differing in crude protein (CP) level and source: FM-18 (18% CP, LT fish meal 10%); partially replaced (SBM-18; FM 5% plus SBM 9%) or supplemented (SBM-20; FM 10% plus SBM 6.3%) with full fat SBM. Diets were supplemented with or without 200 ppm of XTRACTTM, a commercial product based on plant extracts, and with chromium oxide (0.15%) as a digestibility marker. After a 14 days production experiment, the feeding cycle followed a 4-day adjustment period of piglets on ad-libitum feeding half an hour over a one hour and a half periods from 8:00 am to 8:00 pm, and *ad-libitum* over the remainder of the day; on day 5 eight piglets per treatment were slaughtered and jejunum digesta, *enterobacteria* and *lactobacilli* counted (log₁₀/g fresh weight content). Feed Intake (FI, g/d), Average Daily Gain (ADG, g/d) and Organic Matter Digestibility (OMD) were unaffected by diet (p≥0.10). However, FM-18 showed lower Gain to Feed (G/F) ratios (0.67 vs 0.76 or 0.77, p=0.01) and SBM-20 higher CP digestibility (0.849 or 0.861 vs 0.876, p=0.08). Supplementation of XTRACTTM did not affect significantly FI (243.0 vs 248.5), ADG (179.8 vs 178.6), G/F (0.74 vs 0.72) and OM (0.888 vs 0.890) or CP (0.864 vs 0.860) digestibilities. The microbial counts were unaffected by the diet but XTRACTTM promoted a slight but not significant decrease in *enterobacteria* (6.52 vs 6.29,

$p=0.51$) coupled with a significant increase in *Lactobacilli* (5.69 vs 6.26, $p=0.02$). Differences were specially pronounced with the low CP diets (FM-18, SBM-18). It is speculated that microbial differences could improve the digestive stability of the animals and affect performance in a longer time or with stronger stress conditions.

Key Words: Plant extracts, Weaned piglets, *Lactobacilli*

1960 Limiting amino acids in wheat for growing pigs. M. Cervantes*¹, A. Pichardo², M. Cuca², M. Cervantes¹, A.B. Araiza¹, and N. Torrentera¹, ¹Universidad Autónoma de Baja California, Mexicali, Mxico, ²Colegio de Postgraduados, Montecillos, Mxico.

An experiment was conducted to determine the order of the first limiting amino acids (AA) in wheat for growing pigs. Thirty crossbred (Landrace x Yorkshire x Duroc) pigs (22.5 kg initial body weight) were assigned to 5 dietary treatments according to a randomized complete block design. Wheat was the sole source of dietary protein and energy in the test diets. Treatments were: T1) 97.1% wheat, basal diet, T2) + .46% L-lysine, T3) + .46% L-lysine + .14% L-threonine, T4) +.46% L-lysine + .14% L-threonine + .05% DL-methionine, T5) control, wheat-soybean meal diet formulated to contain .83% lysine. Crystalline lysine, threonine and methionine were added, at the expenses of corn starch, to rise their dietary content to .83, .54 and .25% (.54% methionine+cystine), respectively. Vitamins and minerals were added to meet or exceed the requirements for the 50-80 kg pigs. Feed and water were provided ad libitum. Daily gain, feed intake, feed/gain ratio, and intakes of lysine, threonine and methionine were: 241, 430, 598, 615, 513 g/d; 1.24, 1.75, 1.85, 1.93, 1.80 kg/d; 5.29, 4.35, 3.07, 3.18, 3.53; 4.6, 14.6, 15.3, 16.0, g/d; 4.7, 6.7, 9.6, 10.3, g/d; 2.6, 3.7, 3.9, 5.2, g/d, respectively. Lysine addition to the basal diet increased ($P<.05$) daily gain, and intake of feed, lysine, threonine, and methionine; it also improved ($P<.05$) feed/gain ratio. Threonine addition to the lysine-added basal diet resulted in a further increment of growth rate and threonine intake, and improved ($P<.05$) feed/gain ratio. Further addition of methionine increased methionine intake, but the performance of the pigs was not additionally improved. However, the growth rate tended to increase ($P<.15$) as a result of methionine addition. The performance of pigs fed the control, wheat-soybean meal diet was similar to that of pigs fed the lysine-threonine-added diet. These data indicate that lysine and threonine are the first and second limiting AA, respectively, in wheat for growing pigs. Methionine appears to be marginal in wheat-diets for growing pigs.

Key Words: Pigs, Wheat, Limiting amino acids

1961 Comparative nutritional value of wheat, grain sorghum and corn in diets for finishing pigs. A.B. Araiza, M. Cervantes*, S. Espinoza, N. Torrentera, and M. Cervantes, Universidad Autónoma de Baja California, Mexicali, Mxico.

Two experiments, involving 60 crossbred pigs, were conducted to evaluate the comparative nutritional value of three cereal grains (wheat, grain sorghum, and corn) in diets for finishing pigs, under two different weather conditions. Thirty finishing pigs were used in each experiment (59.6 and 53.2 kg initial body weight, respectively), according to a complete randomized block design. Dietary treatments, in both experiments, were as follows: T1) wheat-soybean meal, T2) grain sorghum-soybean meal, and T3) corn-soybean meal; there were five 2-pig replicates per treatment. All diets were formulated to meet the lysine requirement of pigs between the 50-80 kg range weight; vitamins and minerals were added to meet or exceed the requirement. Exp. 1 was conducted during late fall (11.9 and 24.3°C, average low and high, respectively), whereas Exp. 2 was conducted in early summer (19.4 and 38.3°C, average low and high, respectively). Feed and water were provided ad libitum. In Exp. 1, daily gain, feed intake, feed/gain, lysine intake, threonine intake, gain/lysine intake, and gain/threonine intake were: 858, 874, 837 g/d; 2.54, 2.59, 2.67 kg/d; 3.02, 2.99, 3.30; 16.5, 16.8, 17.4 g/d; 13.7, 14.0, 13.6 g/d; 52.2, 53.5, 48.7 g/g; 62.8, 64.4, 62.1 g/g, respectively. There was no difference ($P>.10$) in daily gain, feed intake, feed/gain ratio, lysine intake and threonine intakes, and gain/lysine and gain/threonine ratios, between pigs fed either the wheat-, the grain sorghum- or the corn-based diets, during the winter time. In Exp. 2, ADG, feed intake, feed/gain, lysine and threonine intakes, gain/lysine intake, and gain/threonine intake were: 718, 706, 775 g/d; 2.23, 2.40, 2.42 kg/d; 3.19, 3.42, 3.17; 14.5, 15.6, 15.8 g/d; 12.1, 12.9, 12.4 g/d; 50.3, 45.5, 50.0 g/g; 60.5, 54.8, 63.7 g/g, respectively. As in

Exp. 1, the performance of pigs in this study was not affected ($P>.10$) by the type of cereal grain used in the diet. In average, daily weight gain was higher ($P<.05$) and the feed/gain ratio was better ($P<.05$) during the winter as compared with the summer season. No difference was observed in gain/lysine or gain/threonine ratios between seasons. These data indicate that pigs fed wheat-based diets containing around 50% less soybean meal can perform as well as those fed grain sorghum- or corn-based diets.

Key Words: Pigs, Wheat grain sorghum corn, Performance

1962 Time response effects of cornstarch and raw potatoe starch on the whole-tract digestibility and digestive tract adaptation in growing (20-60 kg) pigs. D. Martinez-Puig¹, J. Morales*¹, J.F. Perez¹, S.M. Martin-Orue¹, and M.D. Baucells¹, ¹Universidad Autónoma de Barcelona.

Twelve growing pigs (Landrace, initial BW 26±3.6) were fed on two diets (6 animals /each) based on ground barley (29%), soybean meal (33%) and purified starch (25%), obtained from either corn (diet C) or raw potatoe (diet P), and characterized by their different content in resistant starch (52g/kg, diet C; 143g/kg, diet P). Diets were offered twice daily at 90% of the predicted voluntary intake. Chromium oxide (0.15%) was incorporated as a flow marker for OM digestibility (OMD) measurements. The experiment lasted 38d reaching the animals an average final weight of 54 kg (55.5 v. 52.9 kg for diet C and P, $P=0.11$). Faecal samples were obtained at day 7, 14, 21 and 38 for the estimation of the whole-tract OMD. On day 27, single doses of Co-EDTA and Cr mordanted wheat bran were administered and the total tract mean retention time (TMRT) was estimated from the faecal marker excretion. On day 38, animals were slaughtered, the whole gut excised, and the stomach, small intestine, caecum and colon ligated, removed and weighed. Whole tract OMD was significantly higher ($P\leq 0.01$) for diet C than diet P on d7 (0.835 v. 0.778) and d14 (0.864 v. 0.790). However, a progressive increase was observed on the diet P digestibility on day 21 ($P=0.08$) and 38, reaching a value on d38 lower but not significantly different from corn (0.861 v. 0.842, $P=0.18$). Hindgut adaptation to diet P was also evidenced by the significant heavier weight of the full digestive tract (7031 v. 8115g, $P\leq 0.05$), full colon (2267 v. 3255g, $P\leq 0.001$), colon digesta (1230 v. 1990g, $P\leq 0.001$) and colon length (3.44 v. 4.12m, $P\leq 0.05$). Despite these results, no significant differences were observed on the TMRT of Cr and Co between diets (Cr, 37.5 v. 42.2h; and Co, 35.9 v. 40.3h for Diet C and P, respectively). It is concluded that a long term period appears necessary to the growing pigs for hindgut adaptation to ferment resistant starch.

Key Words: Resistant starch, Digestive adaptation, Growing pig

1963 Performance and caecal microbial activity of growing rabbits fed different starch levels. A. M. V. Arruda*¹, R. D. Carregal², R. G. Ferreira², and E. S. Pereira¹, ¹Universidade Estadual Oeste Parana, ²Universidade Estadual de Sao Paulo, Brazil.

To evaluate the influence of dietary starch levels on the performance and caecal microbial activity in growing rabbits, four experimental diets were formulated to contain increasing corn starch levels (23, 28, 33 and 38 % total starch levels on a DM basis). White New Zealand rabbits (n=32) were used in a randomized block design. The results showed a decreasing linear effect ($P<0.01$) on food intake and food conversion, where the better rate (108.67 g/d and 3.216, respectively) were obtained with 38% total starch level. However, differences for weight gain and carcass yield were not observed. Regarding caecal microbial activity, pH and VFA production were not significantly affected by the treatments, but the propionic acid concentration showed a decreasing linear effect ($P<0.05$) with the higher molar proportion (12.06 %) observed in the rabbits fed the 23% total starch level. It can be concluded that the starch of corn grain has a higher influence on the caecal microbial activity than purified maize starch, but without significant changes on the performance and carcass yield.

Key Words: Rabbits, Starch, Volatile fatty acids

1964 Apparent digestibility of diets with different starch levels to growing rabbits. A. M. V. Arruda*¹, R. D. Carregal², R. G. Ferreira², and E. S. Pereira¹, ¹Universidade Estadual Oeste Parana, ²Universidade Estadual de Sao Paulo, Brazil.

To evaluate the influence of dietetic starch level on the nutrients apparent digestibility in young rabbits, four experimental diets were formulated to contain increasing corn starch levels (23, 28, 33 and 38 %, total starch levels in dry matter basis). For the digestibility trial, it was used 20 White New Zealand rabbits, assigned to metabolism cages, following a complete randomized design. The results showed a crescent linear effect ($P < 0.01$) to the coefficients of apparent digestibility for DM, OM, NDF and Starch, while that increased dietetic starch level in the experimental diets, where it was verified that the best digestibility (87.26%) was obtained with the 38% of dietetic starch level. It was not observed significant differences to the coefficients of apparent digestibility for CP, CE and ADF by the different starch levels in the experimental diets. However, the best digestibility of fat (89.46 %) was verified with the animals receiving 23% of dietetic starch level. Through this study, it can be concluded that rabbits were efficient in digesting purified starch maize, when this ingredient have a high participation in total carbohydrate fraction of the diets.

Key Words: Digestibility, Rabbits, Maize starch purified

1965 Studying the effect of protein sources on meat quality of pigs using discriminant analyses. Cs. Szabo¹, A.J.M. Jansman², L. Babinszky*¹, E. Kanis³, and M.W.A. Verstegen³, ¹University of Kaposvr, Department of Animal Nutrition, Kaposvar, Hungary, ²ID-TNO Animal Nutrition, Lelystad, The Netherlands, ³Wageningen Institute of Animal Sciences (WIAS), Wageningen, The Netherlands.

Effect of four protein sources (soybean meal, sunflower meal, pea and fish meal as the main protein source) in pig diets on meat quality traits were investigated. A total of 96 individually housed animals (24 per treatment in equal number of barrows and gilts) received the diets from 30 to 105 kg live weight at a level of 3.0 times maintenance requirements of energy. The diets were formulated based on ileal digestible amino acid and ideal protein concepts. At slaughter (105 kg) the traits were determined: lean meat percentage, intramuscular fat content, pH at 45 min and 24 h after slaughter, water loss, meat color (CIELAB) measured 24 h and 4 d after slaughter. The statistical analyses were carried out with GLM and DISCRIM procedures of SAS. Significant difference was not found between protein source treatments regard to ADG, FCR and meat quality. After eliminating the variables having multicollinearity ($r > 0.8$) seven variables remained for discriminant analysis (lean meat percentage, pH₄₅, pH₂₄, WL, L₂₄, Hue₄, IMF). If observations were classified by chance, a 25% accuracy would be expected for the four protein source groups. The animals classified with a 42-74% accuracy to the right treatment based on the traits used. The value of Wilks' lambda (0.77) show a good discrimination, however, it was not significant ($P = 0.38$). These results indicate that although no significant differences could be detected regarding individual variables, an overall effect of protein sources on meat quality probably exists. Similar fattening performance can be expected if protein sources are substituted on the basis of ileal digestible amino acid content and ideal protein concept.

Key Words: Meat quality, Pigs, Protein sources

1966 Feeding value in broiler chicken diets of a potato expressing a β -glucanase from *Fibrobacter succinogenes*. J. Baah*¹, T. A. McAllister¹, T. A. Scott², L. M. Kawchuk¹, J. D. Armstrong³, L. B. Selinger⁴, and K.-J. Cheng⁵, ¹Agriculture and Agri-Food Canada Research Centre, Lethbridge, AB, ²Pacific Agri-Food Research Centre, Agassiz, BC, ³Pacific Agri-Food Research Centre, Summerland, BC, ⁴University of Lethbridge, Lethbridge, AB, ⁵Academia Sinica, Taipei, Taiwan.

A transgenic potato cultivar was evaluated as a source of glucanase in barley-based diets for broiler chickens. Six broiler bioassay diets were formulated from each of two barley cultivars, CDC Silky and Falcon. Diets were unsupplemented (control), supplemented with a commercial poultry enzyme (Avizyme), or had 0.6 or 1.2 kg/tonne of the barley replaced with equal amounts of normal potato (NP) or with potato that expressed a β -glucanase from *Fibrobacter succinogenes* (FSEP). Hubbard High Yield broiler chicks were randomly assigned to the 12 diets

(10 birds/cage; 2 cages/diet). After 3 d on a common broiler starter diet, chicks were given ad libitum access to experimental diets for 14 d. Growth and feed conversion ratios (FCR) were determined by cage. All birds were euthanized on d 17 and viscosity of digesta from the upper portion of the intestine (DV) was determined. On the control diets, growth performance was generally better with Falcon than with CDC Silky. Replacing 0.6 kg/t of barley with FSEP improved ($P < 0.05$) FCR with CDC Silky (1.87 vs 2.05) but not with Falcon; FCR on Avizyme diets was best (1.56; $P < 0.05$). Digesta viscosity was lower ($P < 0.05$) with 1.2 kg/t FSEP in CDC Silky diet than with control (152.3 vs 260.5 cP), but was still much higher ($P < 0.05$) than with Avizyme (31.8 cP). Apparent metabolizable energy (AME) of the diets, based on ileal digesta, was not affected ($P > 0.05$) by NP with either cultivar. With Falcon diets, AME was slightly higher (by 16 and 13%, $P > 0.05$) when 0.6 or 1.2 kg/t FSEP were included, than with no potato (2375.7 kcal/kg). Transformed potato may have potential as a supplementary source of enzyme in barley-based diets for broiler chickens.

Key Words: β -Glucanase-expressing potato, Broiler performance, Barley

1967 Effect of protein fluctuations and space allocation on performance of growing-finishing pigs. M. S. Edmonds*¹ and D. H. Baker², ¹Kent Feeds, Inc., Muscatine, IA, ²University of Illinois, Urbana, IL.

Two trials with growing-finishing pigs (PIC line 356 x Camborough 22) were conducted to evaluate the effects of CP levels and/or space allocation on performance and carcass traits. In trial 1, three CP regimens were used with 216 growing-finishing pigs (mixed sex). Average initial weight of pigs was 31 kg. The CP regimens consisted of 1) control (18% CP wk 0-4; 15% CP wk 4-12), 2) moderate CP variations (MCPV = 19.5% CP wk 0-2; 16.5% CP wk 2-6; 13.5% CP wk 6-8; 16.5% CP wk 8-10; 13.5% CP wk 10-12) and 3) extreme CP variations (ECPV = 21% CP wk 0-2; 15% CP wk 2-4; 18% CP wk 4-6; 12% CP wk 6-8; 18% CP wk 8-10; 12% CP wk 10-12). There were six replications (pens) per treatment with 12 pigs per pen (0.93 m²). During wk 8-12, pigs on the ECPV had improved ($P \leq 0.01$) gain and feed efficiency compared to those on the control regimen. Overall (wk 0-12), there were no treatment differences ($P \geq 0.05$) for gain, feed intake, gain/feed, or percent lean. Trial 2 involved 360 finishing pigs (mixed sex) in a 3 x 2 factorial (three CP regimens, two levels of space). Average initial weight of pigs was 49 kg. The diets consisted of 1) control (16% CP wk 0-4; 15% CP wk 4-8; 14% CP wk 8-12), 2) moderate CP variations (MCPV = 17.5% CP wk 0-2; 14.5% CP wk 2-4; 16.5% CP wk 4-6; 13.5% CP wk 6-8; 15.5% CP wk 8-10; 12.5% CP wk 10-12), and 3) extreme CP variations (ECPV = 19% CP wk 0-2; 13% CP wk 2-4; 18% CP wk 4-6; 12% CP wk 6-8; 17% CP wk 8-10; 11% CP wk 10-12). Pigs were provided with either 1.12 m² (5 pigs/pen) or 0.56 m² (10 pigs/pen). Overall (0-12 wk), crowded pigs had depressed ($P \leq 0.05$) gains (9.8%) and feed intakes (8.3%) compared to uncrowded pigs. A control vs. ECPV x space interaction for overall gain ($P \leq 0.05$) and gain/feed ratio ($P \leq 0.08$) occurred. Thus, uncrowded pigs fed ECPV performed better than controls, but crowded pigs did not. No treatment differences occurred for percent lean. The data suggest that uncrowded, but not crowded pigs, respond positively to up-and-down levels of dietary CP.

Key Words: Pigs, Protein, Space

PSA Nutrition: Phytase and General Nutrition

1968 Pelleting stability of Ronozyme™ P CT phytase in commercial feedmills. N.E. Ward* and J.W. Wilson, Roche Vitamins Inc..

Ronozyme P™ CT (RCT), a phytase, was developed for improved heat stability for pelleted feeds to avoid the need for liquid phytase application. The patented, thin lipid coating of the beadlet reduces enzyme exposure to moisture, one of the two major destabilizing factors for phytase during pelleting. Retention tests were completed in 12 randomly chosen integrated U.S. poultry commercial feedmills. In each case, a total of 0.4 to 0.6 lbs (181 to 272 grams; no carrier) was added per 2000 lbs (907 kg) of feed. A total of 10-20 samples of mash feed were taken as the feed exited the mixer, while 10-20 samples of pelleted feed were obtained at the cooler. Samples were taken at equal-time intervals based on feed flow rate. The percent RCT phytase remaining was 68 to 90% across pellet temperatures of 163°F to 210°F (73°C to 99°C). RCT retention tended to plateau at 70-80%, even at the highest temperatures tested. The mean mixing coefficient of variation (%CV) for phytase was 14.2% in mash, but 12.6% in pelleted feed, an improvement of about 11% in %CV. Mixing during augering and cooling likely accounts for the improved %CV in pelleted feed. RCT phytase retention is no less than about 70% across typical pelleting temperatures, thus serves as a viable, economically attractive alternative to liquid phytase in pelleted feeds. Conditioned mash was 16-17% moisture across mills, and may be the factor that limits RCT phytase destruction at the higher temperatures.

Feedmill #	1	2	3	4	5	6	7	8	9	10	11
Pellet temp., °C	73	80	81	82	89	89	90	91	93	97	99
Pellet temp., °F	163	176	177	180	193	193	194	195	200	207	210
Condition time, sec	20	30	20	35	20	20	25	20	25	20	20
Retention, %	90	82	82	70	72	75	78	80	68	80	75

Retention is percent phytase remaining in pellets relative to starting level in mash; CV = Coefficient of variation

Key Words: Ronozyme P™ CT, Phytase heat stability, Feedmills

1969 Comparison of Ronozyme P™ CT, Ronozyme P™ Liquid and Natuphos® Liquid in a commercial broiler pelleted feed. N.E. Ward*¹, J.W. Wilson¹, and J. McNaughton², ¹Roche Vitamins Inc., Parsippany NJ, ²Solutions BioSciences Inc., Salisbury MD.

Ronozyme P™ CT (RCT), Ronozyme P™ Liquid (RL) and Natuphos® Liquid (NL) were compared in a male broiler floorpen study with feed pelleted at 210°F(99°C)/20 sec by a commercial broiler feedmill. Eight (8) treatments were fed, including positive (POS) and negative (NEG) controls. Final targeted "feed trough" phytase levels were as noted. RCT: 500, 750, 1000 FYT/kg; RL: 500, 750 FYT/kg; NL: 500 FTU/kg. Eight (8) reps/trt were fed for 21 days in floorpens with 50 birds/pen. The feed was a basic commercial corn/SBM diet. Earlier observations indicated a 72-75% retention of RCT when pelleted at 210°F(99°C)/20 sec conditioning, thus RCT was added to the NEG mash at a rate to compensate for expected retention due to pelleting. Liquid phytases were sprayed onto pelleted NEG feed. The right tibia was ashed from 10 birds/pen on day 21.

Total P analysis was 0.57% for NEG and 0.72% for POS control. Average phytase retention across RCT diets was 76%, thus met targeted values. In addition, phytase analysis confirmed targeted values for liquid phytase addition. Body weights were generally improved ($P < .05$) over NEG with phytase addition. F/G and bone ash improved ($P < 0.05$) with increased phytase levels, but no difference in F/G existed across phytase sources at 500 units/kg. RCT and NL at 500 units/kg were equivalent across all variables tested, whereas bone ash for RL (500 FYT/kg) was higher ($P < .05$) than that for NL at 500 units/kg. These results find that RCT can be added to feed prior to pelleting, and retain sufficient quantities to support bird performance that is equivalent to liquid phytases of similar units/kg, and applied post-pelleting.

Trt	Final phytase, units/kg	Total P, %	Body wt., g	F/G	Mortality, %	Bone ash, % DM
POS	68	0.72	692abc	1.379e	1.0ab	38.95c
NEG	21	0.57	677c	1.403f	1.7ab	37.34d
RCT	433	0.55	690bc	1.357bcd	1.5ab	39.03c
RCT	815	0.55	703ab	1.343bc	0.8ab	41.51ab
RCT	1022	0.53	710ab	1.321a	1.5ab	42.7a
RL	527	0.55	702ab	1.364de	2.1b	41.06b
RL	829	0.55	702ab	1.337ab	0.4a	42.2ab
NL	422	0.55	680bc	1.358cd	0.8ab	39.27c

POS = Positive control; NEG = negative control; RCT = Ronozyme P™ CT; RL = Ronozyme P™ Liquid; NL = Natuphos Liquid

Key Words: Phytase, Ronozyme P™ CT and Liquid, Broilers

1970 Comparison of a solid-state fermentation produced phytase with a traditional liquid-fermented phytase in broiler chicks. J Pierce*¹, J Driver², and J Harter-Dennis³, ¹Alltech, Nicholasville, KY, ²University of Pretoria, South Africa, ³University of Maryland Eastern Shore, Princess Anne.

Enzyme preparations produced in solid-state fermentation contain measurable amounts of protease, xylanase, and cellulase, in addition to phytase. An experiment was conducted to compare the efficacy of phytase produced by solid state fermentation (SSF) with a phytase produced by liquid fermentation (LF) containing no measurable enzymatic side activities. One hundred seventy-five 4-d old broiler chicks were used in a randomized block design with 5 dietary treatments and 5 replications of 7 birds/cage for 14 d. Dietary treatments 1-3 contained 0.25, 0.30 or 0.35% available P (aP), respectively. Diets 4 and 5 contained 0.25% aP + SSF or LF phytase (300 PU/kg). All diets were formulated to meet or exceed NRC requirements for all nutrients except P. The corn-soybean meal based mash diets contained 1.0% Ca, 1.26% lys, .97% TSAA, and 3200 kcal ME/kg. Total gain for the five treatments was 336, 363, 365, 362, 352g and gain:feed was 0.70, 0.69, 0.67, 0.69, 0.68. Both forms of phytase improved gain over the control ($P = 0.06$). Tibia ash percentages were 42.7, 46.3, 49.5, 48.2, and 48.1 for treatments 1-5, respectively. In addition, there was a linear improvement in tibia ash percent as P was increased ($P < 0.01$). Similar responses in bone traits were found in tibia strength and toe ash. Based on regression of Treatments 1-3 on tibia ash, it was found that 300 PU/kg of phytase is equivalent to 0.11% of dietary P. The SSF phytase was more effective at reducing fecal P than LF phytase (29 vs 20%, $P = .05$). The results of this experiment indicate that phytase produced by SSF may have advantages over LF phytase in terms of animal performance and P excretion.

Key Words: Chicken, Phytase, Phosphorus

1971 Efficacy of Allzyme Phytase® produced by solid-state fermentation in improving the phosphorus availability of wheat-soybean meal diets for broilers. Y.B. Wu¹, V Ravindran¹, D.T. Thomas¹, B.J. Camden¹, P.C.H. Morel¹, W.H. Hendriks¹, and J. Pierce*², ¹Massey University, Palmerston North, New Zealand, ²Alltech, Nicholasville, KY.

Allzyme Phytase® is an enzyme complex produced by solid-state fermentation, which contains several side-enzyme activities in addition to phytase. The influence of this phytase product on the performance and toe ash contents of male and female broilers fed a wheat-soybean meal diet was investigated in a 6-wk trial. Dietary treatments were: 1) negative control (0.30 and 0.20% nonphytate P during wks 1-3 and 4-6, respectively), 2-4) treatment 1 + 0.06, 0.12, or 0.18% nonphytate P as monocalcium phosphate, and 5-8) treatment 1 + 500, 1000, 1500, or 2000 PU/kg phytase as powder. A 1.4:1 Ca:P ratio was maintained. Diets were cold pelleted (65°C) and, within sex, each diet was fed to 5 pens of 8 birds each. In both sexes, weight gains ($P < 0.05$ to 0.001), gain/feed ($P < 0.05$ to 0.001) and toe ash contents ($P < 0.001$) were increased as the P or phytase was added to the low-P diet. The magnitude of increment in all parameters was greatest for the first addition

of P or phytase and then tended to plateau with further additions. Toe ash contents of birds fed the low-P diet with 500 PU phytase/ kg of diet were comparable to those of birds fed adequate-P diets. Unexpectedly, the birds receiving the low-P diet plus 1000 PU phytase/kg had a similar weight gain and better ($P < .05$) feed efficiency compared to those receiving P-adequate diets. Equations based on performance responses to graded additions of supplemental nonphytate P and phytase estimated the P equivalency of 1000 PU Allzyme[®] phytase/kg of diet to exceed 0.22%. These equivalency values may reflect enzyme activity above that accounted for by phytase activity alone. Thus, the secondary enzymes may have played a part in improving the availability of nutrients from wheat other than P alone.

Key Words: Phytase, Phosphorus, Wheat

1972 Effect of phytase on reduced available phosphorous levels in broiler diets. S. Parhizcar*, A. Kamyab, M. Shivazad, and R. Ashtiani, *University of Tehran, Animal Science Dept..*

A study was conducted to determine the effects of a commercially produced phytase enzyme on feed intake, body weight gain, feed conversion, toe ash, mortality, leg abnormality and blood calcium (Ca) and phosphorous (P) of broilers. This experiment was conducted in a completely randomized design. All of the five diets were isocaloric and isonitrogenous, consisting of five replicates, in which 25 mixed sex day old birds were housed. The experimental diets consisted of: A) basal control diet, B) control diet, but consisting of 85% recommended available phosphorous level plus phytase, C) control diet, but consisting of 85% of the recommended available phosphorous level without phytase, D) control diet, but consisting of 65% of the recommended available phosphorous level plus phytase, and E) control diet, but consisting of 65% of the recommended available phosphorous level without phytase addition. At the end of study, diet D resulted in heavier weight gain and better feed conversion which was statistically significant ($P < 0.05$). At the same age, diet B resulted in higher toe ash and phosphorus serum ($P < 0.05$). Likewise, birds which received diet C had significantly ($P < 0.05$) higher Ca level in their blood. No statistically significant differences were found between carcass quality, mortality and leg abnormalities in the dietary treatments ($P > 0.05$).

Key Words: Phytase, Broiler, Toe ash

1973 Effects of microbial phytase on apparent ileal digestibility of amino acids in broiler chicks fed a corn-soybean meal diet formulated on an ideal protein basis. D. R. Ledoux*, J. N. Broomhead, and J. D. Firman, *University of Missouri Columbia, MO USA.*

A 21-day battery study using 400 day-old male broiler chicks was conducted to determine the effects of microbial phytase on apparent ileal digestibility of nitrogen and amino acids and on apparent metabolizable energy (AME). The 2 X 4 factorial arrangement of treatments included a 100% ideal protein (IP) diet (20% CP) and a 90% IP diet, supplemented with four levels of microbial phytase (0, 250, 500, or 1000 FTU/kg diet) supplied by Natuphos[®]. Ten replicate pens of five chicks were assigned to each dietary treatment. There was no effect ($P > 0.05$) of phytase or IP on feed intake or body weight gain. There was also no effect ($P > 0.05$) of phytase on feed conversion, AME, or nitrogen digestibility. However, chicks fed the 90% IP diet were less efficient ($P < 0.05$) in converting feed to gain, but digested more ($P < 0.05$) nitrogen and utilized more energy (AME) compared with chicks fed the 100% IP diet. Significant ($P < 0.05$) phytase by IP interactions were observed for the dietary essential amino acids threonine, valine, methionine, isoleucine, leucine, phenylalanine, and histidine. Significant ($P < 0.05$) phytase by IP interactions were also observed for the dietary nonessential amino acids aspartic acid, serine, proline, glycine, alanine and cystine. The interactions indicated a benefit for supplementing diets with phytase in chicks fed 90% IP but no benefit for supplementing diets with phytase in chicks fed 100% IP. In addition to the phytase by IP interactions, there was a significant ($P < 0.05$) IP main effect observed for all of the dietary essential amino acids (except for methionine), and most of the dietary nonessential amino acids (exceptions serine and glutamic acid), with chicks consuming the 90% IP having higher digestibilities compared with those consuming the 100% IP diet. Phytase supplementation of a

90% IP diet was effective in increasing apparent ileal digestibility of several amino acids.

Key Words: Chicks, Phytase, Amino acid digestibility

1974 The effect of a non-GMO phytase on the performance of broilers fed diets containing different concentrations of phosphorus. Ruedi Hadorn¹, Hans Wiedmer¹, Samuel Nydegger², and Peter Spring*², ¹*Swiss Poultry Husbandry School, Zollikofen, Switzerland*, ²*Swiss College for Agriculture, Zollikofen, Switzerland.*

The aim of the present study was to determine the effect of a non-GMO phytase on performance of broilers fed diets containing different concentrations of phosphorus. The trial was conducted as a 2x2 factorial design with phytase (E) (0 vs. 1 kg/t) and available phosphorus concentrations (2.65 vs. 3.65 g/kg) as experimental factors. The trial included 4,500 chicks (Ross PM3). Birds were assigned to 20 pens (225 birds per pen) with 16-m² surface each. The sex ratio was 1 to 1 in each pen. Broilers were housed on litter. All animals received the same pre-starter diet for nine days. They received grower diets (13.2 MJ UE, 20.7% CP) from day 10 through 35 and the finisher diet from day 36 through 41 *ad libitum*. The following parameters were determined: Life weight, feed intake, feed conversion, mortality (d10, 21, 35, 41) as well as litter quality, carcass grade and bone breaking strength at day 41. Effects of experimental factors as well as interactions were analyzed by ANOVA. In addition, mean values were compared with the test of Bonferroni ($p < 0.05$). Overall average daily feed intake was increased by phytase addition (90.8 g vs. 93.5 g; $P < 0.05$). The increase in feed intake led to a significant increase in life weight (d41) (2118 vs. 2197g) when phytase was included in the diets. Mean feed conversion was 1.79 and was not affected by treatment. Average mortality over the entire trial period was generally low (1.5%) and not affected by treatment. The production index was significantly higher (279 vs. 290) with the addition of phytase, due to improved weight gain and feed intake. The reduction in dietary phosphorus levels from 3.65 to 2.65 g/kg had no significant effect on animal performance at day 41. There was no statistical difference in litter quality and group uniformity between treatments. Phytase addition tended to improve carcass yield (65.2 vs. 66.0%). Tibia breaking strength (measured as kg/bone) was numerically affected by treatment: high P: - E (44.82 kg) +E (47.30 kg); low P -E (43.27 kg) +E(45.68 kg), however, differences were not significant. This data indicate that non-GMO phytase has the potential to significantly improve animal performance.

Key Words: Phytase, Non-GMO, Broiler

1975 Evaluation of a high coefficient of variation (CV) of phytase consumption on the performance of broilers from 21-42 days of age. J. M. Harter-Dennis*¹, J. Timmons¹, and A. E. Sefton², ¹*University of Maryland Eastern Shore, Princess Anne, MD*, ²*Alltech, Inc., Guelph, Canada.*

A trial was conducted to determine the effects of a high coefficient of variation (CV) of phytase consumption on the performance of commercial broilers during the 21-42 day of age finisher phase. All birds were fed a commercial starter ration from 0-21 days of age that met or exceeded NRC requirements for all nutrients. On day-21 birds were allotted in a RCB design to 4 treatments with 6 reps/treatment and 5 male broilers/rep. Treatments consisted of T1: basal diet (B) containing 3200 kcal/kg ME, 20%CP, 0.9% Ca and 0.15% available phosphorus (AP), T2: B + the recommended level of phytase (11,500 PTU/kg ALLZYME[®], Alltech, Inc) daily, T3: B + 2X the recommended phytase level (23,000 PTU/kg) every-other-day and B on alternate days and T4: B + .20% AP. The CV of phytase consumption of T2 was 0% and that of T3 was 103%. The diets were adequate in all other nutrients. The addition of phytase (T2 and T3) sig. improved tibia bone breaking strength (BBS) and % tibia ash (TA) when compared to the phosphorus deficient diet (T1). Birds fed the AP adequate diet (T4) had tibia BBS and % TA values sig. higher than those fed T1, T2 and T3. There were no significant differences in these parameters due to the %CV of phytase consumption (T2 vs T3). These results confirm that phytase increases dietary phosphorus availability and suggests that older birds from 21-42 days of age may tolerate the high CV's of phytase application often experienced with post-pellet spray systems. These results also confirm similar findings with starter broilers from 0-21 days of age.

Treatment	Gain(g)	G/F	BBS(kg)	%TA
T1	829 ^b	.353	24.2 ^c	45.5 ^c
T2	899 ^{ab}	.393	32.2 ^b	49.2 ^b
T3	942 ^{ab}	.411	31.6 ^b	48.6 ^b
T4	1027 ^a	.417	40.5 ^a	53.5 ^a
ANOVA	P≤.05	NS	P≤.01	P≤.01

Key Words: Phytase, Broilers, Phosphorus

1976 Influence of Allzyme (Phytase) supplementation on Bovans hens. H. Anwar Ahmad^{*1}, S. S. Yadalam², and David A Roland, Sr.², ¹Tuskegee University, ²Auburn University.

A 2x3 factorial experiment to determine the efficacy of supplemental phytase was conducted using 960 40 wks old Bovan hens. Experimental diets were formulated based on two lysine levels, 0.83 and 0.92%. Within each lysine level, a positive control diet containing 0.4% available Phosphorus, a negative control Phosphorus deficient diet containing 0.1% available Phosphorus and the negative control diet supplemented with 11,400 PTU/kg Phytase (Allzyme) were formulated. Performance criteria evaluated were egg production, egg weights, egg specific gravity, and feed consumption. Reducing the lysine level from 0.92 to 0.83% significantly reduced the egg weight and feed consumption but did not drop egg production. Reducing the available Phosphorus level from 0.4 to 0.1% reduced the egg production, egg weight, and feed consumption. Supplying 11,400 PTU/kg phytase (Allzyme) to the negative control Phosphorus deficient diets (0.1%) significantly improved the egg production, egg weight, and feed consumption comparable to those of positive control diets that contained 0.4% available Phosphorus. Feed efficiency of phytase supplemented negative control diets (0.1%) was even better than the positive control diet of 0.4% available Phosphorus. Phytase (Allzyme) supplementation reversed the adverse effects of Phosphorus deficiency and further improved the feed efficiency.

Key Words: Allzyme, Bovans hens, Performance criteria

1977 Effects of dietary supplemental microbial phytase and nonphytate phosphorus on performance, nutrient digestibility and egg quality of laying hens. S. H. Kim^{*1}, W. J. Lee², S. J. Lee¹, D. J. Yu¹, S. Y. Park³, B.S. Kang¹, J. C. Na¹, and K. S. Ryu³, ¹National Livestock Research Institute of Rural Development Administration, Daejeon, ²Daesung Microbiology Co., LTD, ³Department of Animal Resources and Biotechnology, Chonbuk National University.

A total of six hundred forty Hyline brown laying hens were assigned into sixteen treatments to investigate the effect of dietary supplemental microbial phytase and non-phytate phosphorus (NPP) on nutrient digestibility and performance of laying hens. Phytase(Transpos^R) was supplemented at 0, 300, 500 or 1,000 DPU/kg diet. NPP levels were adjusted with tricalcium phosphate(TCP) to be 0 (0.11% NPP), 0.5% (0.20% NPP), 1.0% (0.29% NPP) and 1.5% (0.38% NPP) of diets. Dietary ME, CP and Ca were maintained at 2,800 kcal/kg, 16% and 3.5%, respectively. Egg production, egg weight, feed intake, feed conversion (FC), egg qualities and nutrient digestibility were measured from 21 to 32 weeks of age (WOA). Egg production of birds fed phytase was significantly increased compared to that of non supplemental phytase groups (P<0.05). TCP supplements also significantly improved egg production and daily egg mass up to 0.5% (P<0.05). Egg weight was not different between treatment groups. Feed intake was not statistically different among phytase supplemental groups, however, it was significantly increased with TCP supplementation (P<0.05). FC was significantly improved with phytase supplements (P<0.05), but was not different from FC of those fed TCP supplements. All nutrient digestibilities tended to improve with phytase and TCP supplement, but was not different at various phytase supplementation. The effect of phytase supplement was greater in low phosphorus diets compared to that of NRC recommended levels. Eggshell breaking strength and thickness also improved significantly in phytase supplemental groups (P<0.05). Tibial ash and P content were slightly increased with phytase supplements. However, Ca content was significantly higher in phytase supplemental groups than without phytase groups (P<0.05). As a result, dietary supplemental phytase decreased the level of NPP supplementation necessary. The optimum Transpos^R of diets were estimated to be approximately 300 DPU/kg diets. The results of this laying hen experiment showed that

phytase supplementation improved performance, nutrient digestibility and bone development of birds fed low phosphorus diets.

Key Words: Microbial phytase, TCP, Laying hens

1978 The response of laying hens to phytase added to corn-soybean meal-based diets containing two levels of available phosphorus. 2. Phytate phosphorus utilization. M.A Kamberi¹, H.M. Edwards², G.M. Pesti^{*2}, S. Muratovic³, S. Muji¹, and R.I. Bakalli², ¹University of Prishtina, Prishtina, Kosova, ²The University of Georgia, Athens, GA 30602-2772, ³University of Sarajevo, Sarajevo, Bosnia and Herzegovina.

A trial was conducted to determine the effects of adding phytase (Natuphos[®], BASF) to corn-soybean laying hen diets for 8 weeks with different available phosphorus (AP) levels. After a 14-d adjustment on a common layer diet, 144 Hysex Brown hens were allotted using a randomized complete block design, to four treatments in a factorial arrangement of two AP levels (0.12 or 0.42%) and two phytase levels (0 or 600 FTU/kg). Each treatment was assigned to 3 replicates of 12 hens. Body weight, feed consumption, egg weight, egg specific gravity, and egg shell weights were measured biweekly. Egg production was recorded daily. Total excreta were collected each day and approximately 10% were dried in a forced draft oven. Excreta were pooled by 2-week periods for phytate phosphorus analysis. As reported earlier, the performance of hens fed 0.12% AP + phytase and 0.44% AP without phytase were very similar for egg production (96±2 vs 93±3%), egg weight (63±1 vs 63±1 g), egg shell weight (6.3±0.1 vs 6.4±0.1 g) and feed intake (106±1 vs 105±4 g). Hens fed the diets containing 0.12 and 0.44% AP utilized only 10.6±1.86 and 7.95±0.38% of the phytate phosphorus fed, respectively. When 600 FTU phytase per kg was added to the diets, phytate phosphorus utilization increased to 41.02±1.11 and 33.45±2.95%, respectively. Both the level of AP (P=0.024) and phytase (P<.0001) significantly affected phytate phosphorus utilization (their interaction was not significant, P=0.219). It is concluded that corn and soybean meal diets contain 0.18 to 0.22% phytate phosphorus that can be made partially available by adding phytase to the diet.

Key Words: Available phosphorus, Laying hens, Egg production

1979 Effects of Roche Ronozyme CT on Hy-Line W-98 laying hen performance when fed low phosphorus diets. S. E. Scheideler^{*1}, N. Ward², and M. Jalal¹, ¹University of Nebraska, ²Roche Vitamins.

A 4 X 3 factorial arrangement of 4 levels of Ronozyme CT (phytase) (0, 350, 450, or 550 IU/kg phytase) and 3 levels of nonphytate phosphorus (NPP) (.10, .20 or .30) were fed to Hy-Line W-98 laying hens from 18 to 35 weeks of age. An additional control diet of .45% NPP was also fed. Each of the 13 diets were assigned to 8 replicate cages with 7 hens per cage (56 hens/diet) in a randomized complete block design. Diets consisted primarily of corn-soybean meal with added fat. Daily egg production (EP) and feed intake (FI) were measured. Egg weight (EW) was measured on one day's production weekly and biweekly, 2 eggs/cage were measured for specific gravity, Haugh units and egg components (yolk, albumen and shell). Tibia ash was measured on tibias from 8 hens/diet at the end of the study. Level of NPP and inclusion of phytase significantly affected EP. EP increased with phytase addition at all 3 low levels of NPP and 350 IU/kg phytase was adequate to increase EP at low NPP levels. Low NPP had a negative effect on feed intake which was reversed by the addition of phytase. Tibia ash significantly increased as NPP increased and as phytase was added to low NPP diets. Increasing level of phytase showed some beneficial effects on increasing tibia ash. Diet treatments had no significant effect on EW, but did have a slight effect on albumen content. Increasing NPP decreased proportion of albumen in the egg and egg albumen quality as measured by Haugh units. Proportion of yolk in the egg increased as phytase was supplemented to low NPP diets. Diet effects on % shell and specific gravity were not significant. In summary, Roche Ronozyme CT phytase supplementation of low NPP diets results in equal or better egg laying performance in the Hy-Line W-98 laying hen to a control .45% NPP diet.

Key Words: Phytase, Laying hen, Phosphorus

1980 The evaluation of Ronozyme™ P CT in layer diets. R.D. Miles¹, N.E. Ward*², J.W. Wilson², and D. Ledoux³, ¹University of Florida, Gainesville FL, ²Roche Vitamins Inc., Parsippany NJ, ³University of Missouri, Columbia MO.

This study was conducted to evaluate Ronozyme™ P CT (RCT) and Natuphos® G (NG) for phosphorus (P) replacement in layer diets. A total of 455 HyLine W-36 hens (47 weeks of age) were individually housed. Seven treatments were formulated from a corn/SBM basal diet and replicated 13 times (one rep consisted of five individually-housed hens). RCT was fed at 300, 450 and 600 FYT/kg, while NG was fed at 300 FTU/kg diet. Diets 1, 2 and 3 were formulated to contain 0.1, 0.2 and 0.3% available P (AP). All phytase treatments were added to the 0.1% AP diet. Production data were collected over a 12 week period. The right tibia was removed from 20 actively laying hens/trt for ash determination. Phytase analysis was in agreement with formulated values for phytase. No differences (P>.05) existed across trts for hen-day egg production, although the 0.1% AP diet began to experience lower production by week 4. RCT numerically improved egg production for 0.1% AP trt. From week 4, feed intake was lowest (P<.05) for 0.1% AP trt, but was corrected (P<.05) with added phytase. Hens fed either source of phytase in 0.1% AP diets had equivalent bone ash to hens receiving up to 0.3% AP. An in vitro P release determination found no difference (P<.05) between either source of phytase added at 300 units/kg.

Trt	Phytase units/kg	Egg Prod %	Feed intake g/bird/d	F/G, kg feed/12 eggs	Egg wt. g	Bone ash, % dry matter
0.1% AP	–	74.8	86.5 ^b	1.4	62.0	58.9 ^c
0.2% AP	–	79.0	93.4 ^a	1.43	62.4	59.5 ^{bc}
0.3% AP	–	77.2	93.0 ^a	1.46	62.6	60.5 ^{abc}
RCT	300	77.7	92.2 ^a	1.43	61.8	60.6 ^{ab}
RCT	450	77.7	90.7 ^{ab}	1.41	62.3	59.8 ^{abc}
RCT	600	78.2	93.2 ^a	1.44	62.8	61.3 ^a
NG	300	74.7	91.7 ^{ab}	1.49	62.6	60.6 ^{ab}

AP = Available Phosphorus; RCT = Ronozyme™ P(CT); NG = Natuphos®; abc P<.05

Key Words: Ronozyme™ P (CT), Phytase, Laying hens

1981 Effects of 25-Hydroxyvitamin D₃, vitamin D₃, low phytic acid corn, and phytase on phosphorus utilization by turkey poults fed dietary treatments from hatch to six weeks of age. G. M. Owens and D. R. Ledoux*, University of Missouri Columbia, MO USA.

A floor pen study was conducted to compare the efficacy of 25-hydroxyvitamin D₃ (25-OH-D₃) and vitamin D₃ (V-D₃), on phosphorus (P) utilization by turkeys fed wild-type (NC) or low phytic acid corn (LPC), with or without supplemental phytase. A completely randomized design was used with six dietary treatments and five replicate pens of 10 poults allotted to each dietary treatment from day 1 to 42. Dietary treatments included: (A) NC diet containing 0.60% available P (aP) and 1.2% calcium (Ca), supplemented with 3650 ICU vitamin D₃/kg diet; (B) NC diet as in A, but supplemented with 90 mg 25-OH-D₃ (Hy.D®)/ton instead of V-D₃; (C) NC diet containing 0.44% aP, 1.1% Ca, and supplemented with 600 FTU phytase (Natuphos® 600) and 3650 ICU V-D₃/kg diet; (D) NC diet as in C but, supplemented with 90 mg 25-OH-D₃/ton diet instead of V-D₃; (E) LPC diet containing 0.44% aP, 1.1% Ca, 600 FTU phytase and 3650 ICU V-D₃/kg diet; (F) LPC diet as in E, but supplemented with 90 mg 25-OH-D₃/ton diet instead of V-D₃. Compared with turkeys fed diet A, turkeys fed diet B had similar feed intake (FI) and feed conversion (FC; P > 0.05) but lower body weight gain (BWG; P < 0.05). There were no differences (P > 0.05) in FI, BWG, or FC between turkeys fed diet C and diet D or diet E and diet F. There were no differences in percent toe ash (P > 0.05) among dietary treatments. There were also no differences in percent tibia ash or bone breaking strength (P > 0.05) between turkeys fed diets A and B, diets C and D, or diets E and F. There were no differences in litter P (P > 0.05) between turkeys fed diets A and B, diets C and D, or diets E and F. Litter P was reduced (P < 0.05) in turkeys fed diets containing phytase and lower P levels. Results of this study suggest that 25-OH-D₃ may be as effective as V-D₃ in providing the benefits of vitamin D, and

that phytase was effective in improving phytate P utilization. Results also indicated that LPC contained more available P than NC.

Key Words: Vitamin D, 25-OH-D₃, Turkeys, Low Phytate Corn

1982 Effect of dietary tea polyphenols or daidzein and copper on cholesterol oxide formation in egg yolk powders. Guang-Hai Qi*, Jing-Dong Yin, Qi-Yu Diao, Jun-Jie Zheng, and Qi-Guang Huo, Feed Research Institute, Chinese Academy of Agricultural Sciences, Beijing, China.

Two trials were carried out to examine the effect of dietary tea polyphenols (TP) or daidzein (DA) and Copper (Cu) on lowering egg cholesterol content and cholesterol oxides formation in heated egg yolk powders. A layer diet based on corn-soybean meal-cottonseed meal was used in both trials. One hundred and twenty, 60-wk-old, Hisex laying hens were allocated to one of the 4 treatments of 30 birds with 5 replicates each in each trial. In trial 1, a 2x2 factorial design of TP (0, 40mg/kg diet) and Cu (4, 125 mg/kg diet) was used. A 2x2 factorial design of DA (0, 10mg/kg diet) and Cu (4, 125 mg/kg diet) was also used in trial 2. Both trials lasted 8 weeks. Three eggs were randomly sampled from each replicate and the egg yolks were separated. The three separated egg yolks from each replicate were combined and put in a microwave oven at medium-high temperature for 3 min to make one heated sample. The results showed that dietary supplementation of TP and DA inhibited the formation of 7-keto-cholesterone and total cholesterol oxides (p<0.01). The interactions between TP or DA and Cu on cholesterol formation were not significant (p>0.05). 7-Keto-cholesterone can be used as a marker in measuring egg yolk oxidation or cholesterol oxides formation because of their convenience of detecting and high correlative to total cholesterol oxides. Dietary supplementation of TP, DA and Cu decreased egg cholesterol and triglyceride content (p<0.05), and increased stability of egg lipids by 16.2% (p<0.05), 12.3% (p>0.05) and 5.7% (p>0.05), respectively. Although the interaction between DA and Cu was not significant (p>0.05), the interaction between TP and Cu was significant on reducing egg yolk cholesterol content (p<0.05). Dietary supplementation of TP, DA and Cu significantly reduced total cholesterol and low-density-lipoprotein cholesterol levels in the plasma (p<0.01). This study indicates that dietary supplementation of TP, DA and Cu could improve the healthy quality of egg yolk.

Key Words: Tea Polyphenols, Daidzein, Cholesterol Oxide

1983 Influence of atorvastatin on select indices of lipid metabolism in normolipidemic and hereditary hyperlipidemic chickens. R. G. Elkin*¹, Y. Zhong², S. S. Donkin², C. R. Thomas², E. Hengstschlager-Ottina³, and W. J. Schneider³, ¹The Pennsylvania State University, University Park, PA, ²Purdue University, West Lafayette, IN, ³Biocenter and University of Vienna, Vienna, Austria.

We have previously shown that atorvastatin (AT), a potent 3-hydroxy-3-methylglutaryl-coenzyme A reductase (HMGR) inhibitor, is an effective plasma- and egg cholesterol (CHOL)-lowering agent when fed to normolipidemic (NL) laying hens. In the present study, we extended our sample population to include a unique strain of non-egg laying White Leghorn hens with hereditary hyperlipidemia, the so-called restricted ovulator (RO) chickens, and comparatively examined the effect of AT on select indices of lipid metabolism. NL and RO hens, each 82 wk old and sired by a heterozygous RO carrier rooster, were fed a layer ration supplemented (at 0.06 g/100 g diet) with either microcrystalline cellulose or AT. On d 20, 8 NL and 7 RO hens/diet were weighed and blood samples were obtained; the birds were then euthanized and their livers were excised, weighed, and sectioned for subsequent microsome preparation, mRNA extraction, and lipid, crude protein (CP), and moisture analyses. Compared to NL hens, RO birds were heavier, had markedly larger livers, and exhibited greatly elevated baseline plasma total CHOL and triglyceride (TG) concentrations (156 vs. 455 mg/dL and 3,070 vs. 13,837 mg/dL, respectively). AT attenuated plasma total CHOL concentrations in NL and RO hens by 60.3% and 45.1% respectively, and lowered plasma TG levels in these two groups by 71.0% and 34.3%, respectively. Within each genotype, AT reduced liver total CHOL and fat contents, while levels of phospholipids, CP, and moisture were elevated. AT tended to suppress expression of several key genes involved in hepatic very-low density lipoprotein assembly/secretion (apolipoprotein B, microsomal triglyceride transfer protein, and protein disulfide isomerase) while liver HMGR mRNA levels were elevated by AT in both NL and

RO birds, albeit more so in the former group. AT-associated increases in hepatic HMGR immunoreactive protein levels were noted only in NL birds. Down-regulation of HMGR gene expression by higher baseline levels of circulating CHOL may explain why RO birds, compared to NL hens, responded less robustly to AT administration.

Key Words: Atorvastatin, Lipid metabolism, Restricted ovulator

1984 Modification of the lipid profile of eggs yolks by feeding laying hens different sources of fatty acids. Douglas Faria*¹, Monica Mazalli¹, Daniely Salvador¹, Samir Correa¹, and Diogo Ito¹, *Faculdade de Zootecnia e Engenharia de Alimentos, Pirassununga, SP, Brasil.*

Three hundred and ninety Hy-Line W-36 commercial laying hens 46 weeks of age were fed diets containing different fatty acids sources (3% canola oil, 3% sunflower oil, 3% flaxseed oil, 3% fish oil, a mixture of 1.5% flaxseed oil plus 1.5% fish oil and 9% ground flaxseed), two levels of vitamin E (12 and 100 IU/kg) and a control diet in a factorial arrangement with five replicates of six hens each. Performance and internal and external egg quality characteristics were measured. Concentrations of saturated, monounsaturated and polyunsaturated fatty acids, cholesterol, vitamin E and sensory analysis of the eggs were measured. The results showed no influence of the factors studied on the performance, egg internal quality and egg flavor characteristics. Vitamin E concentration in eggs was related to its dietary levels. Eggshell percent and specific gravity were reduced when 100 IU of vitamin E/kg of the diet was fed. Cholesterol content was slightly reduced by inclusion of greater quantities of unsaturated fatty acids in the diet. The lipid profile in the yolk was modified by fatty acids sources. These findings indicate that it is possible to improve the eggs lipid profile, increase vitamin E content, and use flaxseed as a means of increasing the egg linolenic acid (C18:3n-3) content. The inclusion of flaxseed in the diet induced also the production of eggs with higher concentrations of docosahexanoic acid (C22:6n-3).

Key Words: Cholesterol, Fatty acids, Sensory evaluation

1985 Relationship between objective and subjective measurement of egg yolk colour. X. Rincon-Carruyo¹, R. Sala¹, B. Vila², J. Galobart*¹, and J. Gasa¹, ¹*Universidad Autonoma de Barcelona*, ²*Industrial Tecnica Pecuaria S.A. (ITPSA), R&D Dep., Barcelona Spain.*

An experiment was conducted to evaluate the objective (HunterLab MiniScan Colorimeter; Hunter scale L -lightness-, a -redness- and b -yellowness-, illuminant D65, 10° standard observer) and subjective (Roche Yolk Colour Fan, RYCF) measurement of egg yolk colour, on eggs laid by hens fed 20 different feed treatments obtained as a 4 × 5 factorial design: 4 levels (2.25, 4.50, 6.75 and 9.00 ppm) of natural yellow xanthophylls (CEBSNT, stabilized natural pigment from marigold flowers) and 5 levels (1.125, 2.250, 4.500, 9.000 and 18.000 ppm) of natural red xanthophylls (CFSNT, stabilized natural pigment from paprika). Two-hundred forty Lohmann laying hens, 58 wk old at the beginning of the experiment, were distributed in 40 replicates (6 birds in 2 cages), and 2 replicates were randomly assigned to each treatment. Ten eggs per treatment and day were collected the last 3 days of the 3rd and 4th experimental weeks and evaluated for several quality parameters including egg yolk colour. Performance parameters were also determined for the whole 4-wk experimental period. No significant differences were observed in any parameter but colour measurements of egg yolk. A significant interaction on CEBSNT and CFSNT levels in the diet was observed for all the colour measurements, explained by a significant effect of CEBSNT level at low levels of CFSNT (up to 4.5 ppm), not registered at higher levels. Redness was the best correlated variable with RYCF (r=0.962; n=1034); L and b also showed good negative correlation with RYCF (r=-0.884, and r=-0.876 respectively). The egg yolk colour can be expressed in RYCF units while using the colorimeter for the colour determination, by means of the regression of L a b variables. The equation obtained from this trial (RYCF=5.90+0.396×a-0.205×b+0.051×L; R²=0.929; n=1034) allows an objective measurement of egg yolk colour, independent of light conditions and observer.

Key Words: Egg Yolk Colour, Natural Pigments, Colorimeter

1986 Comparison of inert markers in poultry digestibility studies. P. R. Ferket*, A. D. Israel, and E. B. Morris, *NC State University, Raleigh, NC USA.*

The use of inert markers added to diets in digestibility studies eliminates the need to estimate the total amount of feed intake and fecal excretion. Analysis of chromium from chromic oxide, the most popular digestibility marker, is tedious, time consuming, and hazardous. The objective of this study was to evaluate the use of two alternative inert markers: titanium dioxide (TiO₂) and acid insoluble ash from Celite™, a diatomite product (Celite Corp., Lompoc, CA). Day-old Nicholas male turkeys were randomly assigned to 45 cages containing groups of 10 poults each and allowed to consume one of 9 experimental diets ad libitum until 17 days of age. The experimental diets consisted of a soy-bean meal-basal diet containing corn-based positive control diet and 8 test diets containing wheat in place of corn. These 8 wheat-based dietary treatment were a factorial arrangement of 4 wheat sources (A, B, C, and D) and 2 enzyme supplementation levels. Each diet included .5% TiO₂ and .8% Celite™ (w/w). Pooled fecal collections were made 11-14 d were acidified to pH 5.4 with .1N H₂ SO₄ prior to freezing. Diet and excreta were analyzed for Ti and acid insoluble ash contents, respectively, and AME and apparent N retention (ANR) was determined for each dietary treatment using each digestibility marker. Significant wheat source and enzyme main effects were observed on AME and ANR using TiO₂ as the inert marker, but only significant enzyme effects were observed when Celite™ was used. In comparison to the TiO₂ method, the Celite™ method resulted in higher mean ± SE for AME (2217 ± 47 versus 2346 ± 40 kcal/kg, P<.05) and higher mean ± SE for ANR (34.1 ± 1.2 versus 38.2 ± 1.1, P<.05). Although the Celite™ method is less expensive and easier to perform than the TiO₂ method, it requires bigger sample sizes (10 g versus .1 g) and 2 more replicate samples (i.e. 8 versus 10 replicates) to detect equivalent statistical differences in nutrient digestibility.

Key Words: Digestibility, AME, Nitrogen retention

1987 Additivity of amino acid and energy digestibility in barley and canola meal for ducks. D Hong*¹, D Ragland², and O Adeola¹, ¹*Department of Animal Sciences*, ²*Department of Veterinary Clinical Sciences, Purdue University.*

The additivity of amino acid digestibility and metabolizable energy values in barley and canola meal for White Pekin ducks was investigated in an experiment. The difference between the observed value for a complete barley-canola meal diet and the value predicted from measurements determined for individual ingredients was used to test additivity. Six ducks were assigned to each of the following dietary treatments: 1) barley, canola meal, 2) the complete diet and 3) dextrose. Dextrose-fed ducks were used for estimation of endogenous losses for calculation of true amino acid digestibility (TD). Observed values for the apparent amino acid digestibility (AD) and TD in the complete diet were higher than those predicted from individual ingredients. Observed AD for lysine, histidine, tryptophan, alanine and aspartate were higher (P < 0.05) than predicted values indicating that digestibilities of these amino acids were not additive. The mean of AD in canola meal (77.29 %) was higher (P < 0.05) than the observed values of barley (52.2 %) and the complete diet (64.55 %). For TD values, the differences between observed and predicted were significant (P < 0.05) for lysine, histidine and tryptophan. The mean of TD in canola meal, barley and the complete diet were 85.88, 80.87 and 81.33%, respectively. The AME, TME, AMEn and TMEn in barley and canola meal were all additive. Numerically, the respective AME, TME, AMEn, and TMEn values observed in the complete diet were 0.065, 0.083, 0.016 and 0.023 kcal/g higher than predicted values. These differences between observed and predicted values were not significant (P > 0.05). The AMEn in barley, canola meal and complete diet were 3.205, 2.764 and 3.042 kcal/g, respectively. The experiment provided new information about amino acid and energy utilization in barley and canola meal for ducks and indicated that AME, TME, AMEn and TMEn in barley and canola meal are all additive in the complete diet but that the digestibility of some amino acids are not additive.

Key Words: Barley, Canola Meal, Energy, Amino Acid, Ducks, Additivity

1988 Utilization of various starch sources as affected by age in the chick. A.B. Batal* and C.M. Parsons, *University of Illinois, Urbana, IL USA.*

Two experiments were conducted to determine if age affects utilization of different carbohydrate sources or high-carbohydrate ingredients fed to New Hampshire x Columbian male chicks. Five pens of eight chicks were fed carbohydrate-soybean meal (SBM) diets (23% CP) containing one of 17 different carbohydrate sources from 0 to 21 days of age. Carbohydrate sources evaluated in Experiment 1 were dextrose, conventional cornstarch, dextrinized cornstarch, corn-syrup solids, pregelatinized unmodified cornstarch, pregelatinized tapioca starch, pregelatinized unmodified waxy corn starch, tapioca dextrin, high amylose starch, and polycose. Carbohydrate sources evaluated in Experiment 2 were conventional corn, waxy corn, high-oil corn, cornflour, riceflour, and dextrose. In Experiment 1, the effects of carbohydrate sources on weight gain at the end of Week 1 were as follows (actual weight gains in parentheses): dextrose (88g), polycose (80g), dextrinized cornstarch (79g), tapioca dextrin (78g), corn-syrup solids (74g), cornstarch (70g), pregelatinized tapioca starch (69g), high amylose starch (60g), pregelatinized unmodified cornstarch (41g), and pregelatinized unmodified waxy corn starch (11g) (pooled SEM = 3.8g). Similar relative results were observed for the 0 to 3 week period except that feeding the corn-syrup solids, pregelatinized unmodified cornstarch and polycose were discontinued after Week 1 due to diet texture problems. In Experiment 2, there were no significant differences ($P > 0.05$) in performance during the first week among chicks fed the various corns and flours; however, chicks fed waxy corn, high-oil corn, or dextrose had numerically higher weight gains. By three weeks of age, chicks fed waxy corn, high-oil corn, or dextrose-SBM diets had significantly ($P < 0.05$) higher growth performance than chicks fed conventional corn, cornflour, or riceflour. These results suggest some potential benefits of feeding dextrose, polycose, dextrinized starches, waxy corn, or high-oil corn during the first 1 to 3 weeks posthatching.

Key Words: Chicks, Starch, Carbohydrates

1989 Dietary protein and thyroid interactions broiler chickens. R. W. Rosebrough, *ARS, Beltsville, MD, USA.*

The thyroid axis is one of the more controversial areas in growth and metabolism of the broiler chicken. Although chemical hypothyroidism decreased growth, artificial changes in thyroid hormone levels did not always change growth predictably. While dietary T_3 and T_4 decreased body weight and feed efficiency of chickens, daily injections of thyroid releasing hormone (TRH) improved growth and increased plasma thyroid hormone concentrations. What is lacking from previous studies is any information concerning recovery from inhibition of T_4 production. Male broiler chickens were fed diets containing 12, 18 or 24% protein 1 mg methimazole/kg diet from 7 to 28 d of age and then a diet containing 180 g protein/kg from 28 to 49 d of age. Birds were killed at 28 and 49 days to 1) determine effects of treatments at 28 d and 2) determine carry over effects of these treatments. In vitro lipogenesis was inversely related to dietary protein levels in control birds at 28 d ($P < 0.01$). Dietary methimazole attenuated this effect, resulting in a common rate similar to that attained in the birds fed the highest level of protein without methimazole. In contrast, birds fed methimazole from 7 to 28 d had greater lipogenic ($P < 0.01$) rates at 49 d than did their control counterparts. It is unclear at this time if observations noted at 28 d can be traced to reduced feed intake or to changes in thyroid status. Previous pair-feeding studies from this laboratory confirmed that differences in metabolic parameters caused by differences in dietary protein were not attenuated by limit feeding. Observations at 49 d suggest that permutations in the thyroid of the young bird may substantially change metabolism in later life.

Key Words: Thyroid, Metabolism, Lipogenesis

1990 Dietary protein level and stage of development affect expression of the intestinal peptide transporter (cPepT1) in chickens. H. Chen*, Y-X. Pan, E. A. Wong, and K. E. Webb, Jr., *Virginia Tech, Blacksburg, VA, USA.*

The purpose of this study was to evaluate the expression of chicken intestinal peptide transporter (cPepT1) mRNA as influenced by development and dietary protein level. Straight Cobb chicks (317) obtained from a commercial hatchery were used in this study. Ten were sampled

at incubation day 18 (E 18). After hatch but before feeding, ten more chicks were sampled (d 0). The rest of the chicks were randomly assigned to one of three floor pens. Diets containing 12, 18, or 24% protein were randomly assigned to be fed to the birds in a pen. Feed intake of the birds fed diets containing 18 or 24% protein were restricted to the intake of birds fed 12% protein. Eleven chicks from each group were sacrificed on d 1, 3, 5, 7, 10, 14, 21, 28, and 35. The duodenum, jejunum, and ileum were removed from each bird and were stored at -80°C until total RNA was extracted and quantified by spectrophotometry. Abundance of cPepT1 mRNA was quantified densitometrically from northern blots that were prepared using our full-length cPepT1 cDNA as the probe. An 18s-rRNA cDNA probe was used as an internal control to evaluate the amount of RNA loaded and transferred. At E 18, expression of cPepT1 mRNA in the small intestine was barely detectable. By the time of hatch (d 0), there was an approximately 50-fold increase in cPepT1 mRNA abundance in all three sections of small intestine. In birds fed the 12% protein, a decrease in cPepT1 mRNA abundance was observed in the three sections of small intestine during d 5 to d 10. Afterwards, cPepT1 mRNA abundance remained low throughout the rest of the feeding period. In contrast, both 18 and 24% protein groups showed an increase in cPepT1 mRNA abundance with time in all three sections of the small intestine. Most of the increase occurred during d 5 to d 10. Our results indicate that expression of cPepT1 mRNA in broilers is regulated by both level of dietary protein and stage of development.

Key Words: mRNA, Dietary protein, Development

1991 The effect of early nutrition and refeeding on satellite cell mitotic activity. P. E. Mozdziaik*¹, T. J. Walsh², and D. W. McCoy¹, ¹North Carolina State University, ²Novus International, Inc.

Myofiber growth is dependent upon the contribution of new nuclei from the mitotically active satellite cell population. The objective of this study was to examine satellite cell mitotic activity, in conjunction with different nutritional paradigms, during the early post-hatch period. Turkey poults were either provided a standard turkey starter diet, the starter diet plus a low fat, high protein hydrated nutritional supplement known as Oasis[®] Hatchling Supplement (Novus International, Inc. St. Louis, MO), the starter diet plus Solka-flok-dyed green, or no food for the first 3 days post-hatch. A standard starter diet was provided to all birds between 3 and 9 days of age. Bromodeoxyuridine (BrdU) was continuously infused into all groups (n=5 all groups) between hatch and 3 days of age. A second group of identically treated poults was continuously infused with BrdU between 2 and 9 days of age. Mitotically active satellite cells were identified in the *Pectoralis thoracicus* and quantitated using BrdU immunohistochemistry in combination with computer-based image analysis. Satellite cell mitotic activity was significantly higher ($P < 0.05$) in the birds fed a standard starter diet compared to all other treatments at 3 days post-hatch. However, there were no ($P > 0.05$) differences in satellite cell mitotic activity between all treatments at 9 days post-hatch. The *Pectoralis thoracicus* weight, and the *Pectoralis thoracicus* weight to body weight ratio were significantly higher ($P < 0.05$) in the birds fed Oasis[®] compared to all other treatments at 3 days post-hatch with the fastest birds having the significantly ($P < 0.05$) lowest *Pectoralis thoracicus* weight overall. The larger muscle size observed in the Oasis[®] treated birds at 3 days post-hatch may result from an increase in the amount of protein per nucleus.

Key Words: Turkey, Oasis[®] Hatchling Supplement, Skeletal muscle

1992 Incorporation of n-6 and n-3 fatty acids into selected meat portions from male and female broilers fed sardine oil. Rosa Ma. Castillo Domnguez¹, Silvia Carrillo Domnguez*¹, Ernesto Avila Gonzalez², Benjamin Fuente Martnez², and Fernando Prez-Gil Romo¹, ¹Instituto Nacional de Ciencias Medicas y Nutricion Salvador Zubiran, ²Fac de Medicina Veterinaria y Zootecnia. Universidad Nacional Autonoma de Mexico.

The objective of this study was to compare the incorporation of n-6 and n-3 fatty acids (FA) into leg/thigh and breast muscles lipids of male and female poultry fed sardine oil (SO). 432 one-day-old broiler chicks (males and females) were randomly distributed among four treatments: 0%SO, 0.5%SO, 1.5%SO and 3.0%SO. Feed and water were provided ad libitum. At the end of the trial (6 wk), 3 males and 3 females, randomly selected from each treatment, were killed and legs/thighs and breasts were removed. n-6 (LA,AA) and n-3 (ALA,EPA,DHA) fatty

acids of total lipids were determined by gas chromatography. The results showed that birds supplemented with 1.5%SO and 3%SO had significantly ($P < 0.05$) higher levels of n-3 (25.27, 50.62 mg/100g) than control group (5.65 mg/100g) into breasts. With regard to leg/thigh the higher incorporations of EPA and DHA were obtained with 1.5%SO (20.68, 24.64 mg/100g) and 3%SO (49.17, 43.37). The n-6/n-3 ratios obtained in each treatment were: breast 16.4, 4.7, 3.1, 1.8 and for leg/thigh 16.6, 9.6, 5.4, 2.1. There were not changes induced by the sex ($P > 0.05$). Under conditions of the present study, it is concluded that SO could be used to increase the EPA and DHA content in tissue lipids of poultry, that there is higher incorporation of FA into leg/thigh than in the breast and, than the sex no affect the deposition of FA in the muscle of the birds.

Key Words: Fatty acids, Sardine oil, Broilers

1993 Changes of magnesium and calcium contents and adenosine triphosphatase activity of shell gland mucosa during eggshell formation in Brown Tsaiya ducks and White Leghorn hens. W. L. Chen and T. F. Shen*, *National Taiwan University, Taipei, Taiwan.*

The changes of magnesium and calcium contents, adenosine triphosphatase (ATPase) activity of shell gland mucosa during various stages of eggshell formation in brown Tsaiya ducks and white Leghorn hens

were investigated. Ducks and hens containing an egg in the shell gland were sacrificed at 6, 10, 15, 20 and 22 hours after oviposition, respectively. The whole shell gland lumen was flushed immediately by 50 mL 10 mM Tris-buffer (pH 7.4) for analyzing the amounts of Mg and Ca and their shell gland mucosa were scraped off to determine Mg, Ca contents and ATPase activity. Calcium content in eggshell gland mucosa of both birds decreased to lowest level at 10 hours after oviposition and the data in ducks were lower than hens after active eggshell formation. Total flushed Ca content in uterus lumen of duck or hen were rapidly increased from initial to active stages of eggshell formation. Magnesium content in duck shell gland mucosa was significantly higher ($p < 0.05$) than those in hens from 6 to 20 hours after oviposition. Total flushed Mg content in whole shell gland lumen of chicken was higher than duck after 15-hr stage. The specific activities of Ca^{2+} -, Mg^{2+} - or Ca^{2+} - Mg^{2+} -ATPase in shell gland mucosa were only minor changes ($p > 0.05$) during eggshell formation in both birds. Mg^{2+} added to incubation medium improved uterus mucosa ATPase activity of Leghorn hens, but not in Tsaiya duck. It was concluded that brown Tsaiya ducks could retain higher Mg and lower Ca contents in shell gland mucosa, and secrete less Mg and more Ca to shell gland lumen for depositing in eggshell. The Mg transport mechanism of shell gland mucosa in brown Tsaiya duck is worthy to be further studied.

Key Words: Shell Gland Mucosa, Magnesium, Adenosine Triphosphatase

ADSA STUDENT AFFILIATE DIVISION

Dairy Foods Undergraduate Paper Presentations

1994 Drinking reduced-fat milk may reduce heart disease risk. C.M. Opsahl*¹, ¹*University of Minnesota-St. Paul.*

Cardiovascular disease (CVD) is the major cause of mortality in the U.S. There are multiple risk factors for CVD including genetics, gender, race, age, tobacco use, exercise, diabetes, obesity, hypercholesterolemia, high blood pressure, elevated triglyceride, and high levels of homocysteine (a by-product of protein metabolism). Recent studies have shown that drinking at least four glasses of reduced-fat milk (<2% fat) may significantly reduce the risk of CVD. The exact mechanism of this relationship is not known but there are several possibilities. The dietary calcium from milk has been shown to reduce blood pressure in individuals susceptible to hypertension. Milk drinkers tend to be leaner, have higher levels of good or HDL (high-density lipoproteins) cholesterol, and lower incidence rates of diabetes. Finally, dairy products reduce artery-damaging homocystenine. Don't pass up the milk, drink to your health!

Key Words: Cardiovascular disease, Reduced fat milk

1995 Improving calcium availability with dairy foods and inulin. R. L. Blades*¹, ¹*Louisiana State University.*

Osteoporosis affects millions of Americans each year. This disease, resulting from inadequate calcium bioavailability, is of particular concern to the elderly but may begin during childhood. Only 30% to 40% of the calcium consumed is absorbed by the body, so new methods must be developed for increasing the bioavailability of this important mineral. One way to improve calcium availability is to increase intake of products high in calcium, particularly dairy foods. Another alternative would be to increase calcium absorption from foods. Inulin, an oligosaccharide derived primarily from the chicory root, has been shown to have numerous positive effects on human health. One benefit of this substance is its effect on intestinal flora. This product enhances growth of favorable bacteria while retarding growth of harmful bacteria. One of the most promising aspects of inulin is its ability to increase the intestinal

absorption of calcium. Inulin additive research has been proven to enhance calcium absorption without increasing caloric intake. One study has shown a 20% increase in calcium absorption from yogurt and fermented dairy beverages with only half of the normal usage level. With new technology and the added benefits of inulin, bone loss could be a major concern of the past, and a minor concern for the future.

Key Words: calcium, dairy foods, inulin

1996 Conjugated linoleic acid: Cancer prevention from dairy products. B. E. Dixon*, *University of Kentucky, Lexington, KY.*

Conjugated linoleic acids (CLA) are fatty acids produced by ruminants that are found in meat and dairy products. After the discovery of CLA in meat, a synthetic form of CLA was developed to use in initial research on laboratory animals. In rodents where cancer was induced, consumption of a diet with high levels of this synthetic CLA reduced the incidence of breast, colon, prostate and skin cancer in the order of 50%. Approximately 40% of synthetic CLA are found as the *cis-9, trans-11* form, the isomer responsible for its anti-carcinogenic effects. In natural dairy products, however, at least 90% of CLA are found as the *cis-9, trans-11* isomer. Recent studies feeding butter with high CLA levels to rodents have indicated a similar decrease in cancer incidence and severity. Butter with high concentrations of CLA decreased mammary cancer in one study with rats and colon cancer in another rat model. Similar effects on humans consuming a diet high in CLA can be expected; thus, CLA have great potential in the diet as an anti-carcinogen. Dairy products that include milk fat with increased levels of CLA have a broad potential market. Milk with increased CLA content can be processed with little effect on CLA levels or anti-carcinogenic benefits. Taste tests have shown that butter and milk with high CLA content are considered acceptable by a majority of samplers. Based on a survey, these consumers

were willing to pay more for products containing increased CLA. Future research may lead to the development of a variety of designer dairy products with enhanced, natural, anti-carcinogenic activity for humans.

Key Words: CLA, Cancer, Conjugated linoleic acid

1997 Biotechnology as a means of modifying milk composition. A.E. Lager*¹, ¹*Virginia Polytechnic Institute.*

The dairy industry is reaching a point where the advertising of calcium-laden milk may not be enough to sustain a profitable market for dairy products. Over the past decade, consumers have flocked toward alternative foods, other than milk products, to fulfill their nutritional requirements. Consequently, the time is now for our industry to look for new, improved, and more accelerated ways to modify the composition of milk and provide alternative uses for milk that increase sales. Traditional methods of dairy cattle breeding do not allow for rapid genetic change

Dairy Production Undergraduate Paper Presentations

1998 The importance of biosecurity measures in dairy herds. D.D. Leuty*¹, *Washington State University, Pullman, WA.*

Biosecurity is preventing the introduction of new diseases into a herd by taking some basic precautionary measures. The importance of biosecurity to the dairy industry rises with the increasing prevalence of herds purchasing cattle. Cattle entering the herd can carry contagious diseases from several outside sources. Johne's disease, Bovine Viral Diarrhea (BVD), and Leptospirosis are just a few of the diseases that can be controlled through proper biosecurity. An outbreak of Johne's will decrease the herds production at least five percent and BVD will result in an estimated loss of \$500.00 per cow. One component of biosecurity is isolation of all potential carriers. Such a program includes quarantining all new animals for at least 21 days, testing for highly contagious diseases such as BVD and Johne's, and establishing an aggressive vaccination program. Other measures include increasing herd resistance to disease by reducing stressors, using aggressive colostrum management and limiting access to dairy facilities from outside visitors. The use of biosecurity measures will prevent the spread of disease, decrease the loss of animals, and increase production of the herd.

Key Words: Biosecurity, contagious

1999 Increasing cow milkability. Jana Edwards*¹, ¹*Virginia Tech.*

Milking parlor efficiency is a limiting factor for many dairies. If a parlor is being fully utilized, increasing the amount of milk produced per hour is one alternative to building new facilities or expanding the existing parlor in order to become more profitable. The principle behind good milking technique is that the milking machine should remove the available milk from the udder gently, quickly, and completely with little irritation to the udder. This definition can be used to describe the essential characteristics of good milkability. Good milkability is when the unit is attached and milk flow is apparent immediately after the last teat cup is attached. The cow milks out quickly and completely with a steady milk flow. When the cow is finished milking, milk flow suddenly slows down and the unit is promptly removed from the cow. One way to increase good milkability on a dairy herd is through the implementation of automatic take-off settings. This can be done with an automatic recording system. In order to increase the amount of milk being produced per hour, dairymen must limit the maximum unit-on-time of the milking machine. The typical cow should yield twenty-five pounds in the first three minutes and then eight pounds per minute after that. Once a dairy has no cows milking longer than seven to eight minutes, parlor flow is dramatically more consistent, and the time spent in the holding area is decreased. However, an automatic milking machine is not all automatic. Cows must be properly prepped in order to increase milkability. Cows, with poor preparation, have a longer unit-on-time, which results in a decrease in cows per hour. Cows also tend to have a slower milk let down and a decrease in average flow rates. In conclusion, the time a cow takes to milk out is very important for total time spent in the milking parlor, udder health, and parlor flow. However, proper preparation before milking and properly functional takeoffs must be in

to significantly change milk composition. Milk component modifications can provide for health benefits for the consumer. Researchers have been investigating ways to develop transgenic animals that would produce milk with modified components. Proposed modifications presently being investigated for the benefit of humans include altering protein and fat content, increasing production efficiency, improving food safety, and "humanizing" milk where human proteins would be substituted for bovine proteins in bovine milk. There are several factors currently delaying product availability. These include costliness and inefficiency of transgenic animal production, lack of understanding of mammary gland physiology, and the possibility of milk component interactions. Industry leaders will also have to plan for specialized, separate processing plants for these novel products and be prepared to face potential problems with consumer acceptance of genetically modified products. However, the anticipated benefits will outweigh the current hurdles when the development and follow through of this technology are complete.

Key Words: Biotechnology, Milk, Composition

place for these results to take place. Once the cows are accustomed to being milked properly and efficiently, they will respond by standing quietly, have healthier teat ends, and milk out faster.

2000 The effects of heat stress on conception rates and early embryonic development. I. A. Norris*¹, ¹*Louisiana State University.*

In today's intense dairy industry, the time between freshening and conception is of ever-growing concern. Management during this time plays a role not only in milk production but also in farm efficiency. Simply stated, the sooner dairymen can get heifers and high producing cows pregnant, the more profitable they are as milking units on the dairy. Heat stress in dairy cattle has been associated with negative effects on cyclicity, conception, embryonic development, maternal recognition, and gestation. As the spring and summer rapidly approaches, dairymen in the southern United States must make the decision whether or not to breed heifers and cows during the months of May through September. In studies conducted at the University of Florida, conception rates during summer months commonly drop below 15%. As seasonal temperatures rise, maternal hyperthermia may potentially contribute to uterine heat load. The decreased availability of water and nutrients, along with a decline in metabolic activity needed for proper uterine function and embryonic development, places embryos at higher risk of inadequate growth and potential death. The manner in which dairy cattle are managed during summer months (and other periods of heat stress) may significantly influence reproductive performance. The use of fans, sprinklers, cooling ponds, and shades has been shown to potentially increase conception rates and aid in maintaining pregnancy throughout periods of elevated heat stress.

Key Words: heat stress, conception rates, embryonic development

2001 Agroterrorism: is it a possibility? J.L. Flinchbaugh*¹, ¹*Pennsylvania State University.*

Agricultural biological warfare, or "agroterrorism" as it is known, poses an alarming threat to our society. Agroterrorism may include any activity intended to introduce pathogens into livestock, crops, or directly into processed food products. Currently, the British Ministry of Agriculture is probing the idea that a terrorist group may have planted hoof and mouth disease in an attempt to discredit farming practices. If agroterrorism were truly the cause of this devastating disease outbreak, this act could foreshadow a similar shock to the US dairy and beef industries. The motivation behind most acts of agricultural terrorism is the allure of economic or political gains, with the ease and relatively risk-free nature of agroterrorism serving as added incentives. The ramifications of an act of agroterrorism would be far-reaching, extending beyond the immediate agricultural community to the rest of society. The consequences of agroterrorism are not about food per se, but about the effects on the economic and socio-political infrastructure. Economic destabilization of the agriculture sector would be one of the more immediate effects, followed by a degree of social instability and a loss of confidence in the government. The USDA is taking an active role in the fight against

agroterrorism through such actions as the establishment of the Counterterrorism Policy Council and the Plum Island Animal Disease Center. The development of a national defense strategy against agroterrorism is a necessity if the safety and stability of American agriculture are to be ensured.

Key Words: Agroterrorism

2002 The Advantages and Disadvantages of Accelerated Heifer Growth. M.H. London*, *University of Kentucky Dairy Club.*

Accelerating the growth rate of heifers can help decrease the age at first calving, but this objective must be accomplished without compromising first-lactation or lifetime milk production. Many classical studies done prior to 1990 showed that prepubertal heifers severely overfed energy had decreased amounts of ductal tissue, which resulted in decreased first-lactation milk yields. Studies have shown that heifers from 3 to 12 months of age fed to gain up to 1000 g/d did not result in excessive fattening. However, other research demonstrated a decrease in milk

production of 7.1% when heifers were fed to gain 1000 g/d in comparison to 700 g/d with the accelerated-growth heifers reaching puberty 32 days earlier. Using data present in the literature, VandeHaar concluded that 61% of variation in mammary impairments was attributed to the protein to energy ratio being fed. In another study, feeding a diet with a crude protein to metabolizable energy ratio of 50:1 compared to 61:1 g/Mcal improved feed efficiency, increased structural and overall growth rates, and decreased body condition scores in heifers from 28 to 48 weeks of age. More recent studies also have seen decreases in actual first-lactation milk yield in heifers reared on diets formulated for 1000 g/d gain prepartum. After breeding, all heifers were fed a common diet ad libitum and heifers fed to gain 680 g/d prepubertally showed compensatory gain after puberty with no difference in body condition at calving. These changes in growth after puberty explained most of the differences seen in milk production between the prepartum treatments. Therefore, prepubertal gain may only explain part of the decreases seen in first-lactation milk production. More research needs to be conducted to develop feeding and management programs, which allow for early calving and optimum milk production.

Key Words: dairy heifers, growth

Original Research/Independent Study Undergraduate Paper Presentations

2003 Genetic relationships among electrical conductivity of milk, somatic cell scores and mastitis. R.C. Goodling*¹, G.W. Rogers¹, J.B. Cooper¹, and B. Rune², ¹*Pennsylvania State University*, ²*SAE Afikim, Kibbutz Afikim, Israel.*

Electrical conductivity of milk (EC) increases during mastitis and can be routinely measured during each milking of dairy cattle. The objectives of the study were to examine the relationships among EC, somatic cell scores and mastitis. The Afikim computerized milking and management system measures composite EC in millimho (mmho) during milking and records daily averages for EC. Analyses were performed on 3503 cows sired by 259 bulls in eight herds. Heritabilities for EC were determined using the PROC MIXED procedure of SAS[®] with a model that included herd-year-season, age at calving, and sire. Heritabilities for lactation 1 ranged from .27 to .39; lactation 2 ranged from .21 to .23. Regression of daughter EC on sire PTASCS were all highly significant (.80 for lactation 1 and .67 in lactation 2). Genetic correlations among EC and clinical mastitis incidence were also estimated using a subset of the data where clinical mastitis was present. Bulls with higher PTASCS had daughters with significantly higher EC. The positive regressions and moderate heritabilities from this study indicate that EC might be useful in selecting for mastitis resistance in dairy cattle.

Key Words: Conductivity of Milk, Heritability, Mastitis Resistance

2004 Effects of Propylene Glycol or Fat Drench on Plasma Metabolites and Liver Composition of Transition Dairy Cows. M. M. Pickett*, M. S. Piepenbrink, and T. R. Overton, *Cornell University, Ithaca, NY.*

Forty eight Holstein cows were used to test the effects of short-term oral drenching of propylene glycol (PG) and EnerG II (Ca soaps of

palm oil fatty acids, Bioproducts Inc., Fairlawn, OH) on milk production, blood metabolites, and liver triglyceride composition during the first three weeks of lactation. Treatments (2 X 2 factorial arrangement) given orally once daily for the first three days postcalving were water (Control), 500 ml PG, 454 g EnerG II (Fat), or 500 ml PG plus 454 g Fat brought to a volume of 2.5 L, using warm water. Concentrations of non-esterified fatty acids (NEFA) in plasma tended (P = 0.11) to decrease from day 2 through 7 in cows treated with PG (694.0, 570.7, 684.8, 582.4 μ E/L for control, PG, Fat and PG + Fat, respectively). Concentrations of β -hydroxybutyrate (BHB) in plasma tended (P = 0.09) to decrease from day 2 through 7 in cows treated with PG (10.1, 8.3, 8.9, 8.1 mg/dl). There was a tendency for an interaction of PG and Fat for plasma glucose concentrations (P = 0.07) for days 2 through 7 (36.3, 38.3, 39.4, 37.1 mg/dl), such that concentrations were greater for PG and Fat compared with the control or PG + Fat. Concentrations of triglyceride in liver on d 7 postcalving were not affected by treatment (P > 0.15; 10.82, 6.10, 10.01, 9.96%). Cows drenched with Fat tended to have lower DMI (P = 0.13; 38.0, 39.6, 37.3, 34.9 kg/d) and milk yield (P = 0.13; 36.5, 36.1, 32.5, 34.8 kg/d) during the first 21 d of lactation. There was no effect of treatment on milk composition. There was an interaction of PG and Fat for milk fat yield (P = 0.14; 1.7, 1.5, 1.5, 1.6 kg/d) which led to a trend (P = 0.15) in 3.5% fat corrected milk yield (42.9, 40.3, 38.1, 41.6 kg), such that yields were higher in the control and PG + Fat treatments compared with the other two treatments. Short term drenching of PG as described in this experiment has a slight beneficial effect on concentrations of NEFA and BHB while fat drenches appear to not affect concentrations of these metabolites in early postpartum cows.

Key Words: Propylene Glycol, Fat, Transition Cow

Meat Thermoprocessing: Products and Processes

2005 Thermal Processing of Meat Products. Romeo Toledo*¹, ¹*University of Georgia.*

Meat products are heated to eliminate the bloody red color, set the cured meat color, heat set proteins to form a gel and develop the texture, and thermally inactivate pathogenic and spoilage microorganisms. A number of RTE meat products are water cooked in a flexible film package, cooled, and then the covering is stripped followed by reheating to develop a roast and/or smoked flavor and color. Heating rates must be optimized to maximize color development and minimize purge. Too slow a heating rate will slow down production and may result in excessive shrink. A very fast heating rate will overcook the outer sections before the center reaches the endpoint temperature and results in excessive purge on cooling. Heat transfer mechanisms of conduction, convection, and radiation govern heating rates and different mechanisms predominate in a particular equipment. Surface heat transfer coefficients play a

major role in heating but when the Biot number gets too high, the effect is more on the surface than the interior where conduction becomes the rate limiting mechanism. Radiant heating systems have extremely high surface heat transfer coefficients and are effective for controlling purge and shrink in a post-processing pasteurization process.

Key Words: Heating rates, Post-processing pasteurization, Shrink and purge

AMSA Graduate Student Research Posters (M.S. and Ph.D. Divisions) and AMSA General Abstracts

2006 Effect of potato-processing waste in finishing diets on meat quality from yearling heifers. A. E. Radunz*, M. L. Bauer, G. P. Lardy, M. J. Marchello, and E. R. Loe, *North Dakota State University, Fargo, ND.*

Inclusion of potato-processing waste (PW) was evaluated in high-grain finishing diets fed to one hundred twenty-five crossbred yearling heifers (365.5 ± 0.3 kg initial weight). Heifers were fed for 84 and 105 d. Heifers were blocked by weight and allotted randomly to one of five dietary treatments (5 pens/treatment). PW replaced 0, 10, 20, 30, and 40% of corn and concentrated separator by-product in the diet. As the beginning of the trial, heifers were implanted with estradiol/trenbolone acetate. At harvest, a portion of the shortloin was removed from carcasses in the heaviest four blocks (n=20) and aged for 16 d. After aging, 3 steaks (2.54 cm) were cut from the shortloin, vacuum packaged and

frozen. Color meter readings were taken on the longissimus muscle and subcutaneous fat when the steaks were processed. One steak per heifer was broiled at 185°C to an internal temperature of 70°C and cooled to room temperature. Warner-Bratzler shear force was measured on six cores (1.27 cm). No effect ($P > 0.4$) was observed on fat and muscle color characteristics (L^* , a^* , and b^*) with inclusion of PW. Inclusion of PW did not affect thawing and cooking losses ($P > 0.2$). No difference ($P > 0.2$) was observed for shear force for 0, 10, 20, and 30% levels (3.10, 3.02, 3.11, 3.27 ± 0.15 kg, respectively); however, 40% PW (2.75 ± 0.15 kg) replacement reduced ($P = 0.5$) shear force compared with other levels of PW. Inclusion of PW in a finishing diet does not affect muscle or fat color, cooking characteristics or tenderness; however, inclusion of 40% PW may improve tenderness.

Key Words: Potato-processing waste, beef, meat quality

Meat Thermoprocessing: Products and Processes

2007 Discussion on which ingredients play key roles to food safety and product quality. Dennis Seman*¹, ¹Oscar Mayer Foods Division/Kraft Foods.

Providing food products for consumers that are safe and of a high quality are two pillars upon which meat companies build their businesses. Within the past few years, after the occurrence of a few serious food illness outbreaks in ready-to-eat prepackaged meat products, consumer confidence in the safety of the food supply may have eroded. Several

strategies may provide processors the ability to create secondary barriers for potential pathogenic bacterial growth by the incorporation of additional ingredients including naturally occurring antimicrobial ingredients as well as sodium diacetate and sodium and/or potassium lactate. The use of these ingredients by themselves and in combination with other treatments suggest that they assist in providing a product in which listeria growth is inhibited.

Key Words: Listeria, Sodium diacetate, Lactate